

JOURNAL
OF THE
ROYAL
STATISTICAL
SOCIETY

Digitized by Arya Samaj Foundation Chennai and eGangotri

CC-0. In Public Domain. Gurukul Kangri Collection, Haridwar



110649

पुस्तकालय विज्ञान भवन, गुरुकुल कांगड़ी

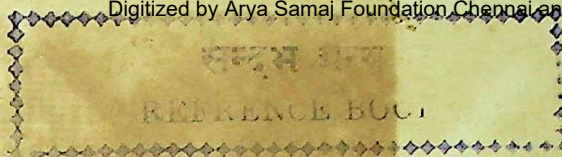
विषय संख्या

पुस्तक संख्या

पञ्जिका संख्या

पुस्तक पर सर्व प्रकार के चिह्न लगाना
वर्जित है। कोई सज्जन पन्द्रह से दिन अधिक
समय तक पुस्तक अपने पास नहीं रख सकते।

यह पुस्तक वितरित न की जाय
NOT TO BE ISSUED



1257

समग्र ग्रन्थ १२५८-१२५९

३२

110649

Digitized by Arya Samaj Foundation Chennai and eGangotri

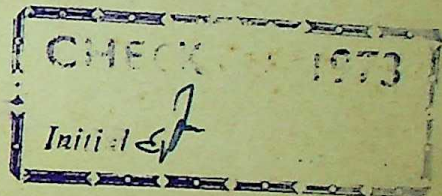


110649

JOURNAL
OF THE
ROYAL
STATISTICAL SOCIETY
SERIES A (GENERAL)

Founded 1834

Incorporated by Royal Charter 1887



Vol. CXIV.—1951

LONDON :
ROYAL STATISTICAL SOCIETY
4, PORTUGAL STREET, W.C.2

ROYAL STATISTICAL SOCIETY

Patron
HIS MOST GRACIOUS MAJESTY THE KING.

COUNCIL AND OFFICERS.—1950-51.

Honorary Vice-Presidents

(having filled the Office of President)

THE RT. HON. VISCOUNT SAMUEL, G.C.B., G.B.E.,
D.C.L.

G. UDNY YULE, C.B.E., F.R.S. (died June, 1951).

SIR ARTHUR L. BOWLEY, C.B.E., D.LITT.,
Sc.D., D.Sc., F.B.A.

H. LEAK, C.B.E.

THE RT. HON. LORD BEVERIDGE, K.C.B., LL.D.,
D.Sc., F.B.A.

ERNEST CHARLES SNOW, C.B.E., D.Sc.
THE RT. HON. LORD WOOLTON, P.C., C.H., D.L.,
LL.D.

DAVID HERON, D.Sc.

SIR GEOFFREY HEYWORTH.

President

PROFESSOR A. BRADFORD HILL, D.Sc., Ph.D.

Vice-Presidents

H. CAMPION, C.B.
R. F. GEORGE.

J. O. IRWIN, Sc.D., D.Sc.
PERCY STOCKS, C.M.G., M.D.

Other Members of Council

PROFESSOR M. S. BARTLETT, D.Sc.

B. BENJAMIN, F.I.A.

W. R. BUCKLAND.

PROFESSOR D. G. CHAMPERNOWNE.

SIR HENRY CLAY, D.Sc.

W. MANNING DACEY.

D. J. DESMOND.

IRIS DOUGLAS.

BERNARD P. DUDDING, M.B.E., Ph.D.

E. C. FIELLER.

PROFESSOR R. A. FISHER, Sc.D., F.R.S.

R. F. FOWLER, C.B.E.

H. O. HARTLEY, Ph.D.

PROFESSOR J. H. JONES, LL.D.

D. G. KENDALL (appt. Dec., 1950).

PROFESSOR M. G. KENDALL, Sc.D.

PHILIP LYLE.

A. H. MARSHALL (res. Dec., 1950).

F. A. A. MENZLER, C.B.E., F.I.A.

PROFESSOR E. S. PEARSON, C.B.E., D.Sc.

PROFESSOR J. H. RICHARDSON, Ph.D.

J. RYAN, C.B.E., M.C.

L. G. K. STARKE, F.I.A.

J. R. N. STONE, C.B.E.

A. W. SWAN.

L. H. C. TIPPETT.

J. WISHART, D.Sc.

Executive Committee

THE PRESIDENT.

THE VICE-PRESIDENTS.

THE HON. TREASURER.

THE HON. SECRETARIES.

IRIS DOUGLAS.

DAVID HERON, D.Sc.

PROFESSOR M. G. KENDALL, Sc.D.

Honorary Treasurer

R. F. FOWLER, C.B.E.

Honorary Secretaries and Editors

R. F. GEORGE.

J. R. N. STONE, C.B.E.

PHILIP LYLE.

Honorary Foreign Secretary

R. F. GEORGE.

Secretary

W. M. CROKER.

Librarian

J. A. KING.

Bankers

ROYAL BANK OF SCOTLAND (DRUMMOND'S BRANCH), CHARING CROSS, LONDON, S.W.1.

Offices

4, PORTUGAL STREET, LONDON, W.C.2.

(Telephone: HOLBORN 4283)

CONTENTS

VOL. CXIV—YEAR 1951.

Part I, 1951

	PAGES
The Doctor's Day and Pay. Some Sampling Inquiries into the Pre-war Status. The Inaugural Address of the President, Professor A. BRADFORD HILL, D.Sc., Ph.D.	1-34
Proceedings of the Meeting	34-37
A Discussion on the Reports of the Royal Commission on Population. Opened by Sir ALEXANDER CARR-SAUNDERS, Sir HUBERT HENDERSON, Sir GEORGE MADDEX, K.B.E., Professor D. V. GLASS	38-49
Earnings and Conditions of Employment in Agriculture. By H. PALCA and I. G. R. DAVIES	50-58
The Agricultural Statistics of the United Kingdom. By D. K. BRITTON and K. E. HUNT	59-98
Reviews of Books	99-115
Statistical and Current Notes	116-119
Obituary:	
L. J. COMRIE	120-121
Statistical and Economic Articles in Recent Periodicals	122-128
Additions to Library	129-134
Periodical Returns: Revenue of the United Kingdom, 1950; Bank of England Weekly Return, 1950	135-137

Part II, 1951

Statistics in Criminology. By M. GRÜNHUT	139-157
Discussion on the Paper	157-162
Differences in Response Rates of Experienced and Inexperienced Interviewers. By J. DURBIN and A. STUART	163-195
Discussion on the Paper	196-206
Note on the Extent of the Public Sector of the Economy in Recent Years. By T. M. RIDLEY	207-213
Historical Survey of the Development of Sampling Theories and Practice. By YOU POH SENG	214-231
Statistics of the Chemical Industry. By A. J. H. MORRELL, F. P. STEVENS and E. W. TALBOT	232-248
Reviews of Books	249-268
Statistical and Current Notes	269-272
Statistical and Economic Articles in Recent Periodicals	273-279
Additions to Library	280-286

Part III, 1951

	PAGES
A Comparison of the Trends of Male and Female Mortality. By W. J. MARTIN	287-298
Discussion on the Paper	299-306
The Influence of Price in International Trade: A Study in Method. By D. J. MORGAN	307-352
and W. J. CORLETT	352-358
Discussion on the Paper	359-371
Some Calculations on Electricity Consumption in Great Britain. By H. S. HOUTHAKKER	372-393
Bibliography of Applications of Mathematical Statistics to Economics, 1943-1949.	394-407
By A. D. SCOTT	408-422
Statistics of the British Motor Industry. By C. V. FORD	423-430
Wholesale Prices in 1950. By THE EDITOR of <i>The Statist</i>	431-434
Reviews of Books	435
Statistical and Current Notes	436-441
Obituary:	442-446
Sir GEORGE EPPS, K.B.E., C.B.	
Statistical and Economic Articles in Recent Periodicals	
Additions to Library	

Part IV, 1951

Indices of Wholesale Prices. By J. STAFFORD	447-459
Discussion on the Paper	460-467
United Kingdom Publishing Statistics. By MARJORIE DEANE	468-489
Urban Population Densities. By COLIN CLARK	490-496
Recent Advances in Mathematical Statistics. Bibliography, 1943-47.	497-558
Annual Report of the Council	559-575
Proceedings of the One Hundred and Seventeenth Annual General Meeting	576
Reviews of Books	577-587
Statistical and Current Notes	588-591
Statistical and Economic Articles in Recent Periodicals	592-595
Additions to Library	596-600
Periodical Returns: Registration of the United Kingdom and Eire, 1946-50	601-604
Index to Vol. XIV (1951)	605

NOTICE

THE Council of the Royal Statistical Society wish it to be understood that the Society is not responsible for the statements or opinions expressed in the Papers read before the Society or published in its *Journal*.

Journal of the Royal Statistical Society

SERIES A (GENERAL)

PART I, 1951.

THE DOCTOR'S DAY AND PAY

Some sampling inquiries into the pre-war status

[The Inaugural Address of the PRESIDENT, PROFESSOR A. BRADFORD HILL, D.Sc., Ph.D.,
delivered to the ROYAL STATISTICAL SOCIETY on November 22nd, 1950]

IN his Henry Sidgwick Memorial Lecture of 1925 Lord MacMillan wittily observed "there is much to commend the institution of an annual namesake Lecture as a means of keeping fresh among us the memory of our departed masters. It ensures that each year one person at least, the chosen lecturer, shall give some thought to the life and work of the great man under whose auspices he is to speak; and his audience, too, if he is fortunate enough to have one, will for a passing hour recall the merits of him who is gone if only to compare them with the shortcomings of the speaker on whom his nominal mantle has fallen". Not unlike this, I fear, is the position of the newly installed President of the Royal Statistical Society. Deeply conscious of the honour the Fellows of the Society have conferred upon him, desperately eager to maintain the high standards set by his predecessors in his office, he not unnaturally begins to study those predecessors a little more closely—their characters, their lives and their works. And inevitably he becomes appalled at his presumption in endeavouring to follow in their footsteps. Then, a little later, there falls upon him the problem of a presidential address. He will have an audience, there is no fear of that—or is there? Remembering the cut and thrust of the Society's meetings he wonders indeed whether he is fortunate or unfortunate. He gloomily foresees the drawing of Lord MacMillan's contrast between the past and present, and his only solace lies in the tradition—jealously upheld by all wise Presidents—that his address cannot be critically discussed.

In short, I come to my task as President of the Society with pride in the honour of my election, and with a hope that my shortcomings may be more than redeemed by my long affection and my future hopes for the Society, for its traditions and its ideals. As regards its immediate demands, the choice of a subject for a presidential address must, I feel, be made with some care. Since, as I have been at pains to point out, it cannot be critically discussed, the controversial must be eschewed. But clearly this introduces a risk of the merely flat and dreary. Refuge, I know, is often taken, and sometimes superbly taken, in those general discussions which rejoice in the titles *Whither Statistics* or *The Arithmetician at the Crossroads*. On the former the Society has already said much in the past few years; the latter has, to me, an unpleasantly suicidal ring about it. I shall, therefore, avoid all such generalities, and seek my refuge in recording some inquiries I have made in the last decade for the British Medical Association into the services given to insured persons by general practitioners before the war, and to the incomes they and their more specialized colleagues earned in those now far-off days. With the advent of the new Health Service in 1948 it is a vanished world of which I write. The structure of the new was, however, partially based upon these figures of the old, and the data may, therefore, be of interest to the historian and the economist. I hope, though with some diffidence, that the statistician too may find a little of interest in the sampling procedures I adopted, even though they may lack the present-day refinements of that science and art.

I. THE DAY'S WORK

The Counting of "A's" and "V's"

Under the working of the National Health Insurance Acts of pre-war days one of the factors taken into account in the fixing of the capitation fee, paid to the general practitioner for each insured person on his panel, was the number of services the doctors were, on the average, called upon to provide. The two main services of which a measure was required were the attendances of patients at the doctors's surgery (*A's*) and the visits by the doctor to his insured patients (*V's*). Since 1925 the British Medical Association had sought to measure the volume of this work by finding through each of its local Panel Committees doctors (to the extent of 10 per cent. of the total) who would be willing to keep a full and accurate daily record throughout the period of the calendar year. Thus for the year 1936 the number of insured persons on the lists of the general practitioners who volunteered was 1,590,207, and the average number of visits paid to them per annum was 1.33 per person, of attendances at surgery 3.80 per person and, thus, of *A's* and *V's* combined 5.13 per insured person.

The Ministry of Health, at a Court of Inquiry into the insurance capitation fee held in 1937, criticized these figures—not unnaturally—on the grounds that they were produced by a volunteer sample. Clearly this sample might not be representative of the total and was, in their view (but without evidence), likely to contain an undue proportion of doctors giving "a much higher average of services than the common level". The Ministry based its own conclusions upon the entries made by practitioners upon the medical record cards relating to each of their insured patients. In 1936 a sample of 336,828 such cards drawn from 660 practices (stratified by type of area) gave an average number of visits of 0.76 per person, of attendances 2.90 per person, and of both combined 3.66. The B.M.A.'s figures for this year were, therefore, in excess of those of the Ministry by 75 per cent. for visits, 31 per cent. for attendances and 40 per cent. for the total. Part of this large difference was certainly due to the fact (admitted by both parties) that *all* the services given by insurance practitioners were *not* recorded by them on their routine cards as required. The Ministry's figures were quite certainly, therefore, an understatement, but to what degree was quite unknown.

Put very briefly and broadly this was the situation in which I was asked by the British Medical Association to devise a more satisfactory scheme of measurement than was provided by either of the above techniques.

The Randomly Selected Sample

It would have been possible, and quite simple, to select a random sample, of any given size, from the total list of Insurance practitioners, and then to ask the doctors so chosen to keep the required records over the ensuing twelve months. The keeping of such special records for a whole year would, however, be a somewhat heavy task in addition to the doctor's normal daily work. There could be no doubt that it would be met by a number of refusals to co-operate, and (what I greatly feared) by lapses during the year of some of those who had accepted the task. Such reductions in the originally chosen group would upset to some extent, possibly seriously, its randomness. It could be argued that those who did keep records for a whole year were again partially self-selected, and therefore not representative of the general body of practitioners. If the refusal and lapse rates were high there could be no effective answer to this objection.

To overcome this difficulty I adopted the following procedure: From the total list of Insurance practitioners (principals only, numbering 17,734) 6,000 names were chosen at random. During this process of selection these 6,000 names were divided, again at random, into twelve groups, and in this way the names of 500 doctors were allocated to each of the months of the year from July, 1938 to June, 1939 inclusive. Each doctor was then asked to keep the required records of attendances by and visits to insured persons *merely for the one month to which he had been allocated*. By these means (a) the whole calendar year, with its seasonal swing of sickness incidence, was covered; (b) for every month a fairly large random sample of the "universe" of practitioners was available to give a measure of services rendered in that month; (c) each doctor

was asked to carry out a relatively small task, but (d) the total number asked to take part was large (rather more than a third of the total body).

To begin with, a complete alphabetical list was made of the names of all medical practitioners on the Medical Lists of all the Insurance Areas of Great Britain and Northern Ireland. The Medical Lists used for this purpose were those published on January 1st, 1938 or shortly after. A practitioner whose name appeared on more than one Medical List was included only once on the alphabetical list. Further, where it was clear from the Medical Lists themselves, or from information in the possession of the B.M.A., that a practitioner was either an assistant or on the Medical List for the sole purpose of treating the insured members of the staff of a hospital or similar institution, this practitioner's name was deleted from the alphabetical list. The remainder, after such deletions, numbered 17,734 names, and this was believed to consist entirely of the principals engaged in insurance medical practice.

To digress for one moment, the numbers below show the numbers of doctors whose surnames began with certain letters of the alphabet:

A . . .	568	J . . .	464	S . . .	1,562
B . . .	1,580	K . . .	424	T . . .	607
C . . .	1,376	L . . .	814	U . . .	27
D . . .	885	M . . .	2,338	V . . .	92
E . . .	382	N . . .	245	W . . .	1,206
F . . .	647	O . . .	335	X . . .	—
G . . .	986	P . . .	747	Y . . .	89
H . . .	1,317	Q . . .	25	Z . . .	6
I . . .	88	R . . .	924		
					<hr/> 17,734 <hr/>

The distribution may be of value to those who like sampling by the initial letter of surnames (which I myself believe to be most unreliable and often grossly fallacious), and to those who may wish to devise coding schemes to include surnames (see, for instance, Professor Lancelot Hogben's ingenious scheme for identifying hospital patients by a 10-figure number—*Brit. med. J.*, 1948, 1, 632)—and to those who are merely arithmetically curious.

Returning to the main issue, the primary object of the inquiry was, as stated above, to secure reliable evidence on the numbers of *attendances* and *visits*. There is always in such inquiries, however, a tendency for interested parties to seize the opportunity to ask a score of other questions. Often this quite natural ardour must, I believe, be firmly restrained by the statistician. A demand for too many golden eggs will almost inevitably lead to an enhanced rate of refusal to co-operate, and to a subsequent lapse rate which will defeat in the end not only this demand but, indeed, the whole inquiry. In this particular instance these additional demands were finally whittled down to five, namely: (a) special, extra or night visits to patients, (b) operations performed, major or minor, (c) injections given, (d) N.H.I. certificates issued, (e) reports made. Even these I believed it would be hazardous to require of each doctor in addition to his ordinary *A*'s and *V*'s. I therefore determined that of the 500 principals allocated to each month of the year, 100 should be asked to make an additional return for *one* of these five items. Thus, in each month all the 500 principals allocated to that month were asked to keep a record of their *A*'s and *V*'s, while 100 were also asked to add particulars of special item (a), 100 to add particulars of special item (b), and so on.

With these requirements and for various practical reasons (which prevented the use of random sampling numbers) the method of selection and allocation adopted was as follows: every third name was taken from the specially constructed alphabetical list, and in strict rotation was allotted to (a) a month of the year and (b) one of the five special groups named above. Thus, the third name on the list was allotted to the month of January and to "special service" (a), the sixth was allotted to January and to "special service" (b), the ninth was allotted to January and to "special service" (c), the twelfth was allotted to January and to "special service" (d), and the fifteenth was allotted to January and to "special service" (e). Numbers 18, 21, 24, 27 and 30 were similarly

allotted to February and to special service group (a), (b), (c), (d) and (e) in order. This procedure produced 5,911 potential record keepers (one-third of the total of 17,734). To bring the number up to the required 6,000, the first name not previously selected was taken from every tenth page of the alphabetical list. These were added in rotation as before.

Holidays, Illness, Instructions

Retention of the original random selection of names and their allocation to the different months of the year was, of course, rigidly maintained. If a doctor allotted to a particular month objected that he would be on holiday during all or part of that month, or was unable to work owing to illness, he was advised that he must make his return just the same, even if that return showed no services rendered whatever. The object of the inquiry was to determine the average number of services rendered to insured persons by an insurance practitioner in a period of twelve months, and as doctors do not invariably work throughout the whole twelve months, proper allowance had to be made for their holidays, illness, etc., by thus requiring returns for the specified period whether the doctor was at work or not.

Similarly, if a doctor argued that his returns would be misleading in relation to the size of his panel list, since, say, as senior partner he had a large list but in fact some of his patients were attended by a junior partner, he was advised that this had no bearing upon the return required of him. His position, he was instructed, would on the average be balanced by the random selection of a junior partner in the reverse position, i.e. with a small panel list and much work to record.

Equally, the absence of recorded services by those on holiday or ill, and not employing assistants or locums, would be balanced by the extra work performed for them by their colleagues. For such reasons no distinction was required in the records between services rendered by the principal to his own patients or to other doctor's patients. He was asked to record services given to any insured person.

These services could, however, be given not directly by the principal himself, but indirectly through his employment of a locum or an assistant. The services rendered by both these classes would clearly be part of the principal's provision for his insured patients. Where, therefore, the principal was employing a locum in all or part of the month for which his record was required, he was instructed to ask the locum to keep the record in his stead, and this was entered as services provided by that principal.

A similar procedure was followed if a single-handed principal employed one or more assistants. In such a case records were required from the assistant, or assistants, as well as from the principal himself. These records were credited to the principal as part of the services provided by him. If, however, the principal were in partnership and one or more assistants were employed by the partnership, only a proportion of the services recorded by the assistant, or assistants, were credited to the principal who had been randomly selected for the month in question; where there were three principals and one assistant the proportion of the assistant's services was taken as one-third, and so on. In the individual case such ratios might, of course, either understate or overstate the assistant's actual contribution to the principal's work but, on the average, with the number of principals involved each month, they should give a proper assessment of the help rendered to them by their assistants. (The actual number of assistants involved was some 14 per cent. of the number of principals making returns in the months of November to April, and 9-12 per cent. of those making returns in May to October.)

Before the beginning of each month the 500 practitioners allocated to it were approached and given a careful explanation of the inquiry and what was required of them. They were provided with a specially printed monthly diary, so that on each day of the month they could record with the least possible trouble (by a tick in a square) their A's, V's and special services. I believe this close and continual attention to minutiae did a good deal to promote the needed co-operation. One instruction perhaps requires special reference, and for obvious reasons. In capital letters the monthly quota were implored not to "undertake additional or unnecessary items, but carry on in the usual way with, as the one difference, a careful recording of every service undertaken". A trifle mendaciously I added, "any deliberate change in your routine invalidates your record," and trusted that the hollowness of the threat might pass unobserved.

The Monthly Samples

As anticipated, it was found that in each month some of the 500 principals were not effective for the purpose of the inquiry and for a variety of reasons, viz. previous death, previous retirement from insurance practice, assistant previously thought to be a principal, etc. These particulars are given in Table 1. Of the total 6,000 doctors originally selected, 423, or 7 per cent., were "ineffective". In the first half of the year of inquiry the number was 185, or 6.2 per cent. of the 3,000 selected; in the second half of the year it was 238, or 7.9 per cent. This increase naturally lies mainly in the larger numbers who had retired from insurance practice, or who had died previously as the month of inquiry became more distant from the date of the Medical Lists originally utilized for the sampling process. Of the remaining 5,577 principals asked to keep the necessary records only the very small number of 46, or less than 1 per cent., refused. However, from a further 113, who had agreed to co-operate, no return could be obtained at the end of their month, making the total losses 159. Returns were, therefore, finally received from 97.1 per cent. of all those who were required to make them, and the lowest percentage in any month was as high as 96.3 per cent. (There is a very slight increase in time in the proportion who made no return, the percentage being 2.5 in the first six months and 3.2 in the second, but the difference is less than twice its standard error.)

The principal making the return had been asked to state the number of insured persons on his individual panel list at the end of the previous quarter. From these figures Table 2 has been constructed to show for each monthly group the number of practitioners who had a given size of panel.

The figures for the total 5,418 doctors who made returns reveal that 22.7 per cent. of them had a panel list of less than 500 insured persons, 27.1 per cent. had between 500 and 999, 21.5 per cent. had between 1,000 and 1,499, 13.9 per cent. had between 1,500 and 1,999, 8.1 per cent. had between 2,000 and 2,499, and 6.7 per cent. had 2,500 or more.

The detailed figures for the separate monthly samples show that no group departs seriously from this distribution for the total, and that each may be regarded as a satisfactory sample (χ^2 42.7, $n = 55$, $P > 0.9$.) Similarly, the average size of the panel differs remarkably little from month to month. For the 5,418 principals this average was 1,148 insured persons, and in the monthly groups the extreme variation is only from 1,090 to 1,196. (There is a very slight rise in the average size of the panel during the year, the figures for the four separate quarters being 1,112, 1,140, 1,153 and 1,188. This might be expected, as estimates of the total insured population showed some increase during the twelve months.)

Further figures regarding the panel lists of the doctors making returns are given in Table 3. They show that there was a total of 6,218,752 insured persons on the lists of these principals, and that 5.0 per cent. of these persons were members of panels numbering less than 500, 17.5 per cent. were members of panels numbering 500 to 999, 23.4 per cent. were on panels of 1,000 to 1,499, 20.9 per cent. were on panels of 1,500 to 1,999, 15.8 per cent. were on panels of 2,000 to 2,499, and 17.4 per cent. were on panels of 2,500 or more. Again, the monthly groups show relatively little variation from this distribution for the total. In each month, it may be noted, the number of insured persons involved is rather more than half a million—a respectable total upon which to base the doctor's *A*'s and *V*'s.

Returning to Table 2, there is given in the extreme right-hand column the distribution by size of panel of those 159 principals who were required to make a return but did not do so. The average size of their panel was 1,072 insured persons, or slightly below the figure of 1,148 found for the doctors who made returns. The distribution of the 159 shows a rather higher proportion of doctors with less than 500 persons on their list (31.4 per cent.) and some deficiency of those with more than 1,500 persons, compared with the figures for the doctors who made returns. These differences are, however, not very great and are not more than might well be due to chance, ($\chi^2 = 9.39$, $n = 5$, P slightly less than 0.10).

Some of those refusing to co-operate did so on the grounds that they were too busy, and a few had unprintable views of the B.M.A. or of the Ministry of Health or of statisticians (occasionally of all three), but, on the whole, it seems likely that this small group of losses did not differ materially from those who co-operated. At any rate it is clear that their number was so small in any month that it could not appreciably disturb the balance aimed at by the random sampling method of procedure.

TABLE I
Composition of the 12 Monthly Samples of 500 Principals July 1938, to June, 1939

	1938												Total
	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	
No longer in Insurance practice	14	4	3	4	2	0	3	3	6	4	2	3	259
An assistant wrongly entered as a principal on alphabetical list	7	3	1	3	11	6	4	5	7	6	7	6	41
Deceased	2	6	2	4	1	3	3	3	5	5	6	5	61
A Medical Officer of a Hospital, etc.	2	1	2	0	1	1	1	1	2	1	0	2	45
No address	1	1	0	1	0	0	1	0	0	0	0	0	13
Not an Insurance Practitioner	0	0	0	1	0	0	1	0	0	0	0	0	2
Duplicate entry in Alphabetical list	0	0	1	0	0	0	0	0	1	0	0	0	2
Total ineffective	26	42	23	28	32	34	44	36	42	37	36	43	423
Refusals to keep records	4	6	6	2	1	1	3	5	5	4	3	6	46
No return made at end of month	9	6	7	12	9	7	10	12	9	12	10	10	113
Total making no returns	13	12	13	14	10	8	13	17	14	16	13	16	159
Number of principals making returns	461	446	464	458	458	458	443	447	444	447	451	441	5,418
Original number selected	500	500	500	500	500	500	500	500	500	500	500	500	6,000
Number making returns as percentage of those who should have made returns (i.e. excluding "ineffectives")	97.3	97.4	97.3	97.0	97.9	98.3	97.1	96.3	96.9	96.5	97.2	96.5	97.1

TABLE 2
Number of Principals with Panels of Different Sizes

Size of Panel	1938						1939						Total	Principals making no returns
	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June		
	Absolute figures													
Under 500	113	102	122	99	104	108	93	102	112	100	87	87	1,229	50
500-999	131	117	119	125	124	115	127	120	112	113	136	130	1,469	35
1,000-1,499	90	104	95	94	94	117	103	90	87	95	108	90	1,167	36
1,500-1,999	65	60	66	68	66	59	58	57	70	60	58	67	754	15
2,000-2,499	39	34	37	38	43	33	31	46	30	44	30	33	438	11
2,500 and over	23	29	25	34	27	26	31	32	33	35	32	34	361	12
Total	461	446	464	458	458	458	443	447	444	447	451	441	5,418	159
	Percentages													
Under 500	24.5	22.9	26.3	21.6	22.7	23.6	21.0	22.8	25.2	22.4	19.3	19.7	22.7	31.4
500-999	28.4	26.2	25.6	27.3	27.1	25.1	28.7	26.8	25.2	25.3	30.1	29.5	27.1	22.0
1,000-1,499	19.5	23.3	20.5	20.5	20.5	25.5	23.2	20.1	19.6	21.3	23.9	20.4	21.5	22.6
1,500-1,999	14.1	13.5	14.2	14.9	14.4	12.9	13.1	12.8	15.8	13.4	12.9	15.2	13.9	9.4
2,000-2,499	8.5	7.6	8.0	8.3	9.4	7.2	7.0	10.3	6.8	9.8	6.7	7.5	8.1	6.9
2,500 and over	5.0	6.5	5.4	7.4	5.9	5.7	7.0	7.2	7.4	7.8	7.1	7.7	6.7	7.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.8
	Average size of panel													
Under 500	237	275	248	231	254	245	252	265	241	249	251	264	251	264
500-999	745	743	734	725	741	728	730	746	746	759	754	746	741	703
1,000-1,499	1,230	1,245	1,219	1,245	1,217	1,244	1,222	1,257	1,238	1,218	1,340	1,246	1,244	1,209
1,500-1,999	1,710	1,731	1,723	1,742	1,723	1,735	1,726	1,722	1,743	1,714	1,690	1,751	1,726	1,751
2,000-2,499	2,240	2,225	2,267	2,234	2,236	2,265	2,210	2,263	2,256	2,291	2,286	2,214	2,250	2,293
2,500 and over	3,264	2,987	2,980	2,944	2,861	3,041	2,885	3,033	3,060	2,993	3,013	2,966	2,998	3,134
Total	1,103	1,145	1,090	1,166	1,135	1,118	1,129	1,183	1,146	1,196	1,180	1,187	1,148	1,072

TABLE 3
Number of Insured Persons on Lists of Doctors Making Returns

Size of Panel	1938						1939						Total
	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	
Under 500	26,774	28,033	30,308	22,916	26,425	26,489	23,470	27,008	27,036	24,909	21,852	23,005	308,225
500-999	97,598	86,975	87,343	90,563	91,921	83,673	92,699	89,494	83,503	85,784	102,494	96,958	1,089,005
1,000-1,499	110,699	129,469	115,829	117,071	114,429	145,589	125,823	113,142	107,683	115,699	144,706	112,131	1,452,270
1,500-1,999	111,137	103,834	113,726	118,489	113,700	102,363	100,116	98,177	121,989	102,816	98,034	117,332	1,301,713
2,000-2,499	87,376	75,635	83,896	84,899	96,137	74,736	68,516	104,094	67,693	100,782	68,593	73,061	985,418
2,500 and over	75,079	86,636	74,490	100,093	77,255	79,072	89,423	97,057	100,967	104,760	96,426	100,859	1,082,121
Total number of insured persons	508,663	510,582	505,592	534,031	519,871	511,922	500,047	528,972	508,871	534,750	532,105	523,346	6,218,752
Under 500	5.3	5.5	6.0	4.3	5.1	5.2	4.7	5.1	5.3	4.7	4.1	4.4	5.0
500-999	19.2	17.0	17.3	17.0	17.7	16.4	18.5	16.9	16.4	16.0	19.3	18.5	17.5
1,000-1,499	21.8	25.4	22.9	21.9	22.0	28.4	25.2	21.4	21.2	21.6	27.2	21.4	23.4
1,500-1,999	21.8	20.3	22.5	22.2	21.9	20.0	20.0	18.6	24.0	19.2	18.4	22.4	20.9
2,000-2,499	17.2	14.8	16.6	15.9	18.5	14.6	13.7	19.7	13.3	18.8	12.9	14.0	15.8
2,500 and over	14.8	17.0	14.7	18.7	14.8	15.4	17.9	18.3	19.8	19.6	18.1	19.3	17.4
Total.	100.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.9	100.0	100.0	100.0

Absolute figures

Percentages

Services Rendered

Coming now to the basic results, the number of *A*'s and *V*'s recorded in each month by the doctors allocated to it are set out in Table 4. By summation the total services given throughout the twelve months by 500 doctors, i.e. including effectives and non-effectives, were 2,138,629 *A*'s and 650,157 *V*'s. The original list used for sampling contained, it will be remembered, 17,734 names, and it may reasonably be presumed that this contained the same proportion of ineffectives as the sample of 6,000. Therefore, by simple proportion, and *counting the ineffectives and the doctors who made no returns as having given no services at all*, the services rendered in the year by the total 17,734 doctors would have been: *A*'s 75,852,893 *V*'s 23,059,768.

TABLE 4

The Total Number of Attendances and Visits Recorded in Each Month

Month	"A's"	"V's"
1938		
July	159,419	43,127
August	153,727	40,106
September	166,004	43,148
October	173,273	48,245
November	181,204	52,603
December	163,705	59,566
1939		
January	208,663	77,976
February	201,064	71,373
March	208,046	67,919
April	182,502	53,042
May	179,662	49,788
June	161,360	43,264
Total	2,138,629	650,157

These figures must be related to the total insured population, and official estimates were obtained of the number of insured persons entitled to medical benefit at five different points of time, between July 1st, 1938 and July 1st, 1939. For the four quarters of the year concerned these figures gave totals of 20,620,808, 20,757,523, 20,810,685 and 20,832,180. Taking their mean gives a figure of 20,755,299 for the whole year. From this figure, however, a small reduction must be made for those insured persons who obtained medical benefit through Approved Institutions and for those who made their "own arrangements" for medical benefit. For the period in question the former was estimated at 154,592, and the latter at 21,555. The resulting figure, therefore, for the number of insured persons to whom the services given above should apply was 20,579,152.

I reach then the following results: number of *A*'s per insured person per annum 3·69, number of *V*'s 1·12, number of *A*'s and *V*'s 4·81. These figures must, however, inevitably understate the services actually given to the entire population of insured persons entitled to medical benefit for two reasons, namely (i) the doctors who should have made returns but failed to do so have been counted as giving *no services whatever* in their month, and (ii) any services given by doctors not on the medical lists utilized for sampling at the beginning of the year of inquiry are automatically excluded since no new entries were brought into the picture. In other words, the exits by death or retirement have been counted as giving no services, and any new entries who took their places have not been included. Under the first heading the omission cannot be very serious, for the number of doctors who neglected to make returns was, by virtue of the experimental design, very small. If, in fact, the 159 doctors who made no returns actually gave in the month to which they were allocated the same amount of services as those who did make returns, then the figures for the total would become 3·79 *A*'s, 1·15 *V*'s, with a total of 4·94, an increase of less than 3 per cent. •Under the second heading above, however, the omissions may be rather

more serious for 320 principals, or roughly 5 per cent. of the 6,000, had retired or died, and presumably their places had been taken by new entries to the panel lists for whose work no allowance has been made in the calculation above.

An alternative method of calculation may, however, be made by using the return given by the sample practitioners of the number of insured persons on their individual panel lists (see Table 3). The services actually rendered in each month (Table 4) may be divided by the number of insured persons involved in that month (Table 3). The results are shown in Table 5, where the figures clearly reveal the expected seasonal swing in the services given. They rise from a minimum in the summer months to a peak in the first quarter of the year, when influenza and respiratory diseases are prevalent, and then decline by June to the original figure from which they started in the previous July.

TABLE 5
*The Services Rendered per Insured Person per Month by
those Principals who made Returns in Each Month*

	"A's"	"V's"
1938		
July	0.31	0.085
August	0.30	0.079
September	0.33	0.085
October	0.32	0.090
November	0.35	0.101
December	0.32	0.116
1939		
January	0.42	0.156
February	0.38	0.135
March	0.41	0.134
April	0.34	0.099
May	0.34	0.094
June	0.31	0.083
Total for the year	4.13	1.257

Now, if the services given by these monthly groups be taken as representative of the services given by the whole body of doctors in each month of the year, then summation for the twelve months gives the following figures per insured person per annum: *A's* 4.13, *V's* 1.26, *A's* and *V's* 5.39. These figures may overstate the average services given by a doctor in the year in question, for they are based only upon the doctors who made returns in each month. Those who neglected to make returns may have been given less services than those who did make returns, and the same might be true of the new entries to the profession succeeding those who died or retired during the year and who were not included in the samples. (Allowance, as previously pointed out, was made for holidays or illness.)

The figures resulting from the two different methods of calculation differ, however, by only 12 per cent., and the average services rendered by doctors in the year of inquiry is likely, it appears, to lie within this quite narrow range. (It may be of interest to note that half way between the two series gives 5.10 *A's* and *V's*, a figure practically identical with that of 5.13 put forward for the year 1936 by the B.M.A. on the basis of its volunteer sample!)

The Uniformity of the Monthly Groups

Before passing to the "special" services recorded by the smaller groups of practitioners it is, I think, of importance to consider the uniformity of the returns made by the larger groups keeping records of their *A's* and *V's*.

(a) Table 6 shows the distribution of the services given over the different days of the week, and reveals a remarkable uniformity for the different monthly groups. The only material departures from the general pattern of work are in December and April, for which the Christmas and Easter holidays were responsible. In the remaining ten months the maximum

number of attendances always falls on a Monday (varying only from 19.9 to 21.4 per cent. of the total, and the next busiest day is always a Saturday (17.1 to 19.0, per cent. with a suggestion of a season swing); this is followed by Friday and Tuesday (15.7 to 17.0 and 15.6 to 16.5 per cent.), and lastly by Wednesday and Thursday (13.3 to 14.2 and 12.4 to 14.1 per cent.). On Sunday the attendances are only a little more than 1 per cent. of the total, and show, as might be expected, some evidence of a seasonal swing as illness becomes more prevalent.

TABLE 6

The Services Rendered by Practitioners on Each Day of the Week
Percentage distribution

“A's”	1938						1939					
	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
Sunday	1.3	1.4	1.5	1.5	1.6	1.2	1.4	1.4	1.5	1.4	1.1	1.2
Monday	21.2	20.9	21.3	20.8	21.1	17.5	19.9	21.4	20.7	17.7	21.1	20.7
Tuesday	15.7	16.5	16.1	16.1	16.0	15.0	16.3	15.6	16.4	18.3	16.3	16.3
Wednesday	13.7	13.9	13.8	13.9	13.3	16.1	13.4	14.2	13.5	15.4	13.7	13.6
Thursday	13.7	13.1	13.6	13.5	14.1	14.0	13.3	12.4	13.1	13.9	13.4	13.7
Friday	17.0	16.4	16.6	16.2	15.7	17.4	16.7	16.0	15.9	14.0	16.5	16.5
Saturday	17.4	17.8	17.1	18.0	18.1	18.9	18.9	19.0	19.0	19.3	17.9	17.9
Total	100.0	100.0	100.0	100.0	99.9	100.1	99.9	100.0	100.1	100.0	100.0	99.9
“V's”												
Sunday	6.4	6.3	6.6	6.4	6.4	6.1	6.5	6.1	6.2	6.5	6.3	6.3
Monday	18.0	17.9	18.1	17.9	18.3	16.5	17.7	18.3	18.3	17.2	18.6	17.9
Tuesday	15.1	15.6	15.5	15.3	15.4	14.8	14.6	14.9	15.4	15.9	15.5	15.6
Wednesday	14.7	14.6	14.4	14.8	15.0	15.7	15.0	15.4	14.7	15.7	14.7	15.1
Thursday	14.5	14.2	14.6	14.2	13.9	14.7	14.5	14.2	14.5	14.5	14.5	14.1
Friday	16.1	16.3	16.2	16.2	16.3	16.4	16.1	16.1	15.8	15.0	15.9	16.2
Saturday	15.2	15.1	14.6	15.2	14.7	15.7	15.7	15.1	15.2	15.2	14.5	14.8
Total	100.0	100.0	100.0	100.0	100.0	99.9	100.1	100.1	100.1	100.0	100.0	100.0

The Table is read as follows: For each month the services given were added for four Mondays, four Tuesdays, four Wednesdays, etc. The services given on each day were then expressed as a percentage of the total services given in the four complete weeks. Thus in July 1.3 per cent. of the attendances in four complete weeks were on Sundays, 21.2 per cent. were on Mondays and so on. The odd days in a month were omitted.

With visits, excluding again the abnormal months of December and April, Monday is again in each month the busiest day (17.7 to 18.6 per cent. of the total); this is followed by Friday (15.8 to 16.3 per cent.). With the remaining days there is some variability from month to month, but the prevailing order is Tuesday (14.6 to 15.6 per cent.), Wednesday or Saturday (14.4 to 15.4 and 14.5 to 15.7 per cent.), with Thursday last (13.9 to 14.6 per cent.). About 6 to 6½ per cent. of visits are made on a Sunday, a higher proportion than with attendances, as might be expected. Boxing Day in 1938 fell on a Monday, and the proportion of services given in December on Mondays is thereby depressed. Easter Week fell in April, and the proportion of services is similarly depressed on Monday and Friday. These expected changes in the weekly pattern and the striking uniformity in the remaining months are, I suggest, important evidence that the records were efficiently kept (and even may convince the non-statistician of the reliability of a sample).

(b) Table 7, and Fig. 1 based upon it, shows the average number of services rendered per practitioner per day in each week of the year from July 1st–7th, 1938 to June 23rd–29th, 1939. It reveals the extent to which the records of one monthly sample linked up with those of the next, and any abrupt changes which took place in passing from one sample to the next. (The method of calculation of the figures for weeks in which the groups changed may be shown by the following example: in the week July 29th–August 4th the July sample of 461 doctors gave 17,061 services in three days, and the August sample of 446 doctors 24,485 services in four days. The total services provided per day in this week were, therefore, 41,546/7, or 5,935, and the average number of

doctors providing these services was $(3 \times 461 + 4 \times 446)/7$, or 452.4. The average services per doctor per day was, then, 13.1.)

TABLE 7

The Average Number of "A's" and "V's" Given per Doctor per Day in Consecutive Weeks

Week		"A's" and "V's" per Practitioner per Day	Week		"A's" and "V's" per Practitioner per Day
July	1-7 . . .	14.7	Dec. 30-Jan. 5 . . .		18.6
	8-14 . . .	14.6	Jan. 6-12 . . .		21.3
	15-21 . . .	14.1	13-19 . . .		21.7
	22-28 . . .	14.0	20-26 . . .		21.0
	29-Aug. 4 . . .	13.1	27-Feb. 2 . . .		21.8
Aug.	5-11 . . .	13.9	Feb. 3-9 . . .		22.1
	12-18 . . .	14.1	10-16 . . .		22.4
	19-25 . . .	14.0	17-23 . . .		21.3
	26-Sept. 1 . . .	14.3	24-Mar. 2 . . .		21.4
Sept.	2-8 . . .	14.5	Mar. 3-9 . . .		21.1
	9-15 . . .	14.9	10-16 . . .		20.1
	16-22 . . .	15.4	17-23 . . .		19.2
	23-29 . . .	15.1	24-30 . . .		19.1
	30-Oct. 6 . . .	15.2	31-Apr. 6 . . .		20.0
Oct.	7-13 . . .	15.4	Apr. 7-13 . . .		15.9
	14-20 . . .	15.8	14-20 . . .		18.3
	21-27 . . .	15.8	21-27 . . .		17.8
	28-Nov. 3 . . .	17.0	28-May 4 . . .		17.3
Nov.	4-10 . . .	17.4	May 5-11 . . .		16.8
	11-17 . . .	17.0	12-18 . . .		16.3
	18-24 . . .	16.3	19-25 . . .		16.2
	25-Dec. 1 . . .	16.6	26-June 1 . . .		14.9
Dec.	2-8 . . .	16.6	June 2-8 . . .		15.8
	9-15 . . .	16.4	9-15 . . .		15.3
	16-22 . . .	14.7	16-22 . . .		15.0
	23-29 . . .	13.7	23-29 . . .		15.3

It will be seen that on the whole the records of the adjacent monthly groups link up extremely well. The July group shows a slightly slackening activity during the passage of its month, reaching a minimum as the sample changes—in the August Bank Holiday week. Subsequently there ensues a fairly steady rise in the amount of work done, lasting until the end of October. A rather abrupt rise takes place with the advent of the November group—from 15.8 in the week October 21st–27th to 17.0 in the week October 28th–November 3rd. This higher figure was maintained for a couple of further weeks and the services then decline to a low point in the Christmas week. They rise steeply with the influenza epidemic that began at the turn of the year. The figure, it will be seen, fell in the last complete week of January (21.0) but rose again with the entry of the February sample (21.8), to reach a peak in the middle of that month (22.4). It seems likely that this change in trend was not due to the change in the samples at this point, for the records of deaths from influenza in the Great Towns of England and Wales suggest that this, in fact, was the course of the influenza epidemic—a decline at the end of January rising again to a maximum towards the end of February (deaths must, of course, lag behind cases). The sequence of work then follows a steady downward path, broken only by a peak prior to the Easter Holiday (Easter Monday

1951]

BRADFORD HILL—*The Doctor's Day and Pay*

13

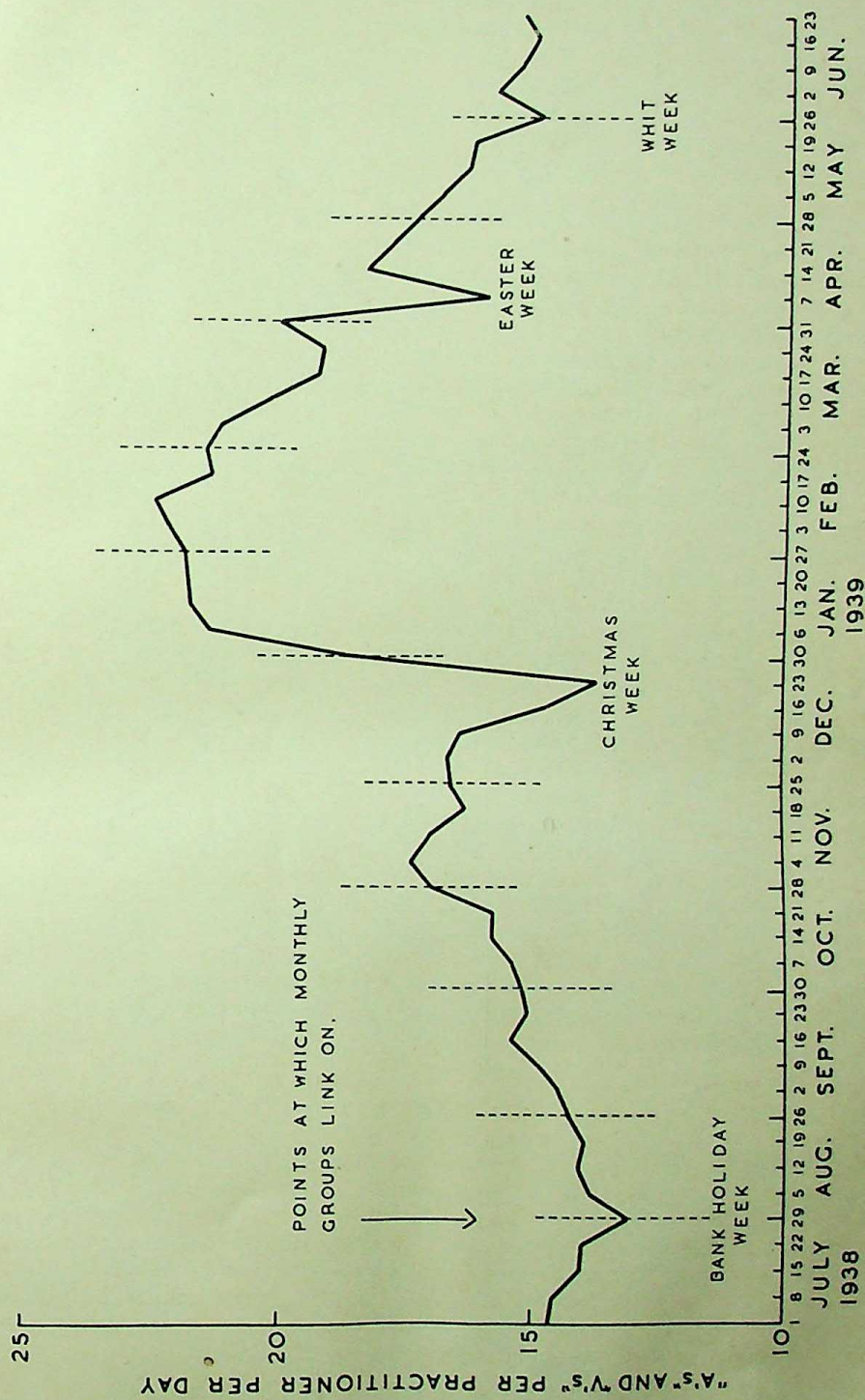


FIG. 1.

TABLE 8
The Number of Services Given by Doctors in Different Months
Percentage of Doctors Giving Services Specified in Left-hand Column

Number of Services Given in each Month	1938						1939					
	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
"A's"												
0-199	37.6	37.8	36.4	33.9	30.4	33.6	24.8	26.9	24.6	31.4	29.9	32.7
200-399	30.8	29.6	29.7	27.5	29.3	31.2	30.7	29.4	27.2	29.3	28.4	30.6
400-799	23.6	25.4	25.1	28.1	31.0	27.0	26.8	28.2	32.4	26.8	31.8	30.0
800 or more	8.0	7.2	8.9	10.4	9.4	8.2	17.6	15.4	15.8	12.6	10.0	6.8
Total	100.0	100.0	100.1	99.9	100.1	100.0	99.9	99.9	100.0	100.1	100.1	100.1
Mean number of "A's" per doctor	346.5	346.4	364.0	383.2	389.9	362.2	473.0	450.9	470.3	409.5	401.2	368.6
Standard deviation	287.0	282.6	310.2	306.7	303.9	291.7	383.0	350.2	376.1	336.3	310.7	290.6
Coefficient of variation	83	82	85	80	76	81	81	78	80	82	77	79
"V's"												
0-49	34.1	36.5	34.5	30.6	22.5	27.9	16.0	17.0	20.5	27.1	25.7	33.1
50-149	46.0	44.4	47.0	46.5	51.1	39.6	34.1	39.1	38.3	42.0	49.9	46.7
150-249	16.0	13.9	13.5	15.5	17.7	20.7	27.1	26.2	24.5	20.8	17.3	15.0
250 or more	3.9	5.2	5.0	7.4	8.7	11.8	22.8	17.7	16.7	10.1	7.1	5.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Mean number of "V's" per doctor	95.5	93.2	94.5	108.7	116.3	131.7	177.6	160.2	155.3	121.5	112.9	99.5
Standard deviation	79.2	77.5	77.6	95.1	88.8	121.0	135.4	125.1	138.4	99.0	90.8	80.4
Coefficient of variation	83	83	82	88	76	92	76	78	89	82	80	81

was April 10th) and a drop in Whit week (Whit-Monday was May 29th). They finally link up with the level from which they set out a year previously.

The only change of trend of any magnitude for which an explanation is not forthcoming is, therefore, that of the first three weeks in November, when an average of 16 services per day might have been expected in place of the recorded 17. This November sample did not differ appreciably in its composition by size of panel from that found for the total 5,418 doctors (see Table 2), and the final figures given by it link up successfully with those of the December group. It seems likely, therefore, that some general increase in work was indeed required in the first weeks in November.

(c) In Table 8 particulars are given of the number of services performed per doctor in each month. The variation in work done by individual doctors was, of course, very great, since the size of the doctor's panel is not taken into account in this form of calculation, and also because individual circumstances differed widely. Some principals rendered no services whatever in their month, e.g. they were on holiday, and their patients were attended by a partner; others with a large panel list and employing an assistant, or assistants, rendered between two and three thousand services in their month. The percentages in Table 8 show what proportion of doctors rendered a given number of services in their month. For example, in July, 1938, of the 461 doctors keeping records for that month 37.6 per cent. recorded between 0 and 199 attendances, 30.8 per cent. recorded between 200 and 399 attendances, 23.6 per cent. recorded between 400 and 799 attendances, and the remaining 8 per cent. recorded 800 attendances or more. In January more than twice as high a proportion (17.6 per cent.) recorded 800 or more attendances.

From these distributions the mean number of services per doctor could be calculated, and also the measures of variability round this mean. (They were in fact calculated from distributions with a much smaller class interval.) These figures show once more the seasonal trend of the doctor's work. The third quarter of the year, July–September, was relatively light; the last quarter October–December showed some increase, especially in visits; in the first quarter the maximum activity prevailed; in the second quarter the work again declined, to link up satisfactorily in June with the figures for the previous July. In this table, however, the coefficients of variation are of particular interest, for they show that in spite of the changing distributions and changing averages the variability from one group of doctors to another keeps remarkably uniform. In respect of attendances the coefficients all lie in the narrow range 76 to 85, and eight of them are between 78 and 82. In respect of visits the range is rather greater, namely from 76 to 92, but nine of the coefficients lie between 76 and 83. Such uniformity again suggests that the groups were good samples and that the records were efficiently kept.

(d) The average number of A's and V's rendered per doctor according to the size of his panel list was calculated for those making returns in each month. Simple addition of the monthly averages gave the quarterly figures shown in Table 9. Those with large panel lists naturally gave more services than those with smaller lists but, as Table 9 shows, the seasonal swing in services rendered was practically identical in the three groups differentiated by size of panel. Calling the number of services rendered in the July–September quarter 100, the increase in work in the following

TABLE 9

The Number of Services Rendered per Doctor per Quarter in Panels of Different Sizes

Size of Individual Panel	Average Number of A's and V's per Doctor in Each Quarter			
	July–Sept.	Oct.–Dec.	Jan.–Mar.	April–June
Under 1,000	740	802	1,047	799
1,000–1,999	1,631	1,798	2,236	1,773
2,000 or over	2,744	2,991	3,794	3,069
<i>Ratios to July–September Quarter</i>				
Under 1,000	100	108	141	108
1,000–1,999	100	110	137	109
2,000 or over	100	109	138	112

TABLE 10
Returns of "Special Services" in Each Month

	1938						1939						Total	
	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June		
Special, extra or night visits														
(1) :	990	1,016	840	959	967	1,416	1,441	1,049	1,129	1,261	960	802	12,830	
(2) :	89	90	93	89	94	90	89	88	84	88	86	91	1,071	
(3) :	11.1	11.3	9.0	10.8	10.3	15.7	16.2	11.9	13.4	14.3	11.2	8.8	144	
Operations, major and minor														
(1) :	854	1,048	932	1,090	1,581	1,149	1,259	1,158	1,092	1,279	1,878	857	14,177	
(2) :	92	86	92	89	93	93	88	92	89	95	93	88	1,090	
(3) :	9.3	12.2	10.1	12.3	17.0	12.4	14.3	12.6	12.3	13.5	20.2	9.7	156	
Injections														
(1) :	980	777	769	1,016	1,001	785	673	821	773	793	789	831	10,008	
(2) :	97	94	91	93	90	93	89	91	90	88	89	83	1,088	
(3) :	10.1	8.3	8.5	10.9	11.1	8.4	7.6	9.0	8.6	9.0	8.9	10.0	110	
N.H.I. Certificates														
(1) :	10,867	12,304	11,691	13,704	11,344	10,241	16,168	18,328	19,504	12,528	12,371	12,267	161,317	
(2) :	89	88	95	95	89	93	89	90	97	86	93	87	1,091	
(3) :	122.0	139.8	123.1	144.3	127.5	110.1	181.7	203.6	201.1	145.7	133.0	141.0	1,773	
Reports and Correspondence														
(1) :	1,946	2,459	1,975	2,958	2,459	2,049	3,094	2,142	1,943	1,955	2,729	2,374	28,083	
(2) :	94	88	93	92	92	89	88	86	84	90	90	92	1,078	
(3) :	20.7	28.0	21.2	32.2	26.7	23.0	35.2	24.9	23.1	21.7	30.3	25.8	313	
	(1) Number of services recorded in the month.						(2) Number of doctors recording.						(3) Average services per doctor.	

(3) Average services per doctor.

(2) Number of doctors recording.

(1) Number of services recorded in the month.

quarter was 8–10 per cent., in the first quarter of 1939 it was 37–41 per cent., in the final quarter it fell again to 8–12 per cent. This test of the uniformity of the figures gives once more a satisfactory result.

I thought it right originally to make all these somewhat tedious tabulations of the data and now to include their analysis for two reasons. It is sometimes difficult to convince the layman that quite a small sample, efficiently drawn, can provide the evidence he requires. In this inquiry 500 out of nearly 18,000 appears to have adequately fulfilled the purpose. The second reason was much more important. The weakness as well as the strength of my technique lay, I felt, in the short period of time—one month—for which the practitioner had to supply a record. For such a short time the focusing of the microscope might lead to some change in the normal daily routine. In particular, an excess of zeal might lead to an increase in the services normally given to patients—or at least this point might be argued before any court of inquiry. A strong and specific warning was, it will be recalled, given against any such change in habits. If it were disregarded on a large scale I thought the result might well reveal itself in the final figures. For instance a deliberate stepping up of services by the practitioner would not, I believed, be maintained throughout the month. The excess of zeal would die away as the four weeks passed by. If this in fact occurred the results given upon the introduction of a new monthly sample would not link up smoothly with the results given by the departing sample of the previous month. A serrated curve should ensue. There is no sign of it in Fig. 1. I find impressive, too, the great consistency in behaviour revealed by the different groups, e.g. in the daily routine shown in Table 6 (and behind it the fact that one could tell from the original records upon which day of the week the doctor took his half-day off!). In the winter months of heavy demands it would be difficult to increase the day's work, in the summer months it might be easy. Yet the groups at different points of time show the same patterns of behaviour, the same degrees of variability round their averages.

In short, while these many figures add nothing directly to the required measure of *A*'s and *V*'s, indirectly, I suggest, they add very considerably to the confidence one can place in the results of the inquiry.

The "Special" Services

As previously stated, in addition to the main returns of *A*'s and *V*'s, records were kept of five "special services", 100 doctors being allocated at random for the recording of each service in each month. The basic figures resulting from this inquiry are given in Table 10. They show that the total number of doctors making such returns was in each case just under 1,100, giving a monthly average of approximately 90; the monthly samples lay between 83 and 97.

Following the procedure of the main investigation the following results are reached:

	(1)	(2)	(3)
	100 principals gave the following services during the year	By simple proportion 17,734 principals gave the following services during the year	Taking the insured population as 20,579,152 gives the following special services per 100 insured persons per annum
Special visits	12,830	2,275,272	11.1
Operations	14,177	2,514,149	12.2
Injections	10,008	1,774,819	8.6
Certificates	161,317	28,607,957	139.0
Reports	28,083	4,980,239	24.2

As previously noted, this method somewhat understates the true position. Alternatively, an estimate of the average number of "special services" rendered per doctor per annum may be

computed by summation of the monthly figures for those actually making returns. The following results are found:

"Special Services" Rendered per Doctor

	<i>Per annum</i>	<i>Per week</i>
Special visits	144	2.77
Operations	156	3.00
Injections	110	2.12
Certificates	1,773	34.10
Reports	313	6.02

Summary of the Day's Work

(1) An inquiry was made to determine the number of services rendered by Insurance practitioners to insured persons in Great Britain and Northern Ireland in the year July 1st, 1938, to June 30th, 1939.

(2) A random sampling method was adopted to ensure that the doctors making returns were an unbiased sample of the total population of insurance doctors. From a total list of 17,734 such doctors (limited to principals) 6,000 were thus selected. They were divided at random into twelve equal groups, and each group of 500 was asked to keep the required records during one month of the year specified. A further division into groups of 100 was made, and each of these sub-groups was asked to keep records of a defined "special service" during one month of the year.

(3) Of the 6,000 selected doctors, 423, or 7 per cent., were unable to make returns owing to retirement from practice, death, etc., before their month's records were required. Only 159, apparently at work, neglected to make returns.

(4) The monthly groups showed very considerable uniformity in their composition, e.g. in the sizes of the panel lists of the doctors concerned, and in the characteristic features of their records, e.g. in the distribution of work over the days of the week, in the variability from one group of doctors to another of the number of services rendered. It appears that the monthly samples were, therefore, satisfactorily representative of the universe from which they were drawn, and that the records were well kept.

(5) From the data provided by these means and from estimates of the insured population to whom the services of all insurance practitioners are rendered, it is concluded that in the year in question the average number of attendances and visits per insured person per annum lay between the following limits, which differ by only 12 per cent.:

Number of A's per insured person per annum	3.69-4.13
Number of V's per insured person per annum	1.12-1.26
Number of A's and V's per insured person per annum	4.81-5.39

(6) It is estimated that the numbers of "special" services rendered during the year were of the following order:

	<i>Special Services per 100 Insured Persons per annum</i>	<i>Special Services Rendered per Doctor per week</i>
Special, extra or night visits	11.1	2.77
Operations, major and minor	12.2	3.00
Injections	8.6	2.12
Number of N.H.I. certificates issued	139.0	34.10
Number of reports and correspondence made	24.2	6.02

II. THE INCOME OF THE GENERAL PRACTITIONER

The outcome of the previous inquiry into the doctor's services was, of course, upset by the outbreak of World War II. With the advent, after the war, of the Government's Scheme for the

New Health Service a wholly new basis of remuneration for the general practitioner had to be sought. For this purpose the first "Spens" Committee was appointed (in February, 1945), an inter-departmental committee with the following terms of reference: "to consider after obtaining whatever information and evidence it thinks fit, what ought to be the range of total professional income of a registered medical practitioner in any publicly organized service of general medical practice; to consider this with due regard to what have been the normal financial expectations of general medical practice in the past, and to the desirability of maintaining in the future the proper social and economic status of general medical practice and its power to attract a suitable type of recruit to the profession; and to make recommendations". Arising out of the reference to the "normal financial expectations of general medical practice in the past", I was asked by the British Medical Association to undertake a statistical inquiry into the general practitioner's pre-war earnings.

The Sample

There was, fortunately, a ready-made "universe" which could be sampled without difficulty. The Central Medical War Committee had, before the outbreak of World War II, compiled a card register of all medically qualified persons with information upon the nature of their professional work. It had been kept up to date, and at February 5th, 1944, contained 52,414 names in alphabetical order. It would have been possible, but extremely onerous, to scrutinize every one of these cards, and thus to isolate the universe of those in general practice in 1938. It was clearly simpler to take every n^{th} card throughout the register, and isolate as the sample required those relating to the general practitioners of 1938. Since there were in 1945 some 21,700 general practitioners, a sample of one in four of the total cards in the register should provide about 5,000 doctors who were in practice in 1938. A large sample of this nature was required, since many subdivisions of it would have subsequently to be made. This, then, was the procedure followed, and the one in four sample in fact produced 5,066 names (principals and assistants).

This sample suffered, it is clear, from one very serious defect—it could include only *those in practice in 1938 and still alive in 1945*. There was no way of bringing in the dead who had been in practice in 1938 (unless with official aid through income tax returns held by the tax inspectors, and with such information on type of practice as was available in the war register). This loss would differentially affect the older age-groups, and thereby give incorrect weightings to the age groups if all ages were combined. It had to be accepted—and remembered.

A closer study of the 5,066 names that had been drawn revealed that 168 had not in fact been in practice in 1938. Deleting these left 4,898 persons from whom information was required. With the exception of ten known to be prisoners of war a questionnaire was sent to each, and upon this they were asked to state the amount of professional income earned (gross and net) and their professional expenditure in each of the three years, 1936, 1937 and 1938, the figures to be based on accounts rendered to and accepted by the Inspector of Taxes. If the practitioner were in partnership during one or more of the three years only his own share of the partnership income and expenses and his own professional expenses were to be given. Professional fees from all sources were to be included. I personally regretted the extension of the inquiry to cover three years, since I believed the increased demand would militate against co-operation. Professional opinion was, however, that the year 1938 might not be normal, and that its excursions and alarms might have adversely affected the doctors' earnings. Other information asked for included the nature of the practice (urban, rural or mixed), the doctor's year of entry into general practice, the share of partnership in appropriate cases, the amount of income from National Health Insurance fees for those in single-handed practice, the number of assistants employed, and any unusual circumstances affecting the income in any of the three years under inquiry.

The Response

The response to this inquiry was, after the previous success, very disappointing. From the replies it was found that 362 of the 4,888 approached had not in any of the years in question been in general practice as desired (a few had been acting as locum tenens). This left 4,526 returns to be made, and of these only 3,008 were finally collected in a satisfactory form (an unsatisfactory handful had to be deleted subsequently). In other words, *only two-thirds* of the required sample were obtained. A small proportion, 3.6 per cent., resolutely declined to provide

the information, a large proportion, 20·0 per cent., made no response to repeated requests, and from 9·9 per cent. information could not be obtained for a variety of reasons (lost and incomplete records were the main items). Table 11 sets out these serious losses in the different age-groups and reveals that the refusal rate was associated with age, declining from nearly 10 per cent. at ages 65 and over to 2 per cent. at ages 34 and below. On the other hand, taking no notice of letters was not a function of age. In total, the proportion of the required returns which was received was fairly stable at ages below 65, varying between 65 and 70 per cent. At ages above 65 it was only 55 per cent.

TABLE 11

Summary of Returns Made and Reasons for no Return

	Ages						Total
	65+	55-64	45-54	40-44	35-39	34 and below	
Number of returns required	339	562	919	721	954	1,031	4,526
Refused to give information	33	37	35	17	22	21	165
Percentage	9·7	6·6	3·8	2·4	2·3	2·0	3·6
Made no reply to repeated requests	67	104	173	171	191	201	907
Percentage	19·8	18·5	18·8	23·7	20·0	19·5	20·0
No information obtainable*	52	41	64	55	94	140	446
Percentage	15·3	7·3	7·0	7·6	9·9	13·6	9·9
Returns received	187	380	647	478	647	669	3,008
Percentage	55·2	67·6	70·4	66·3	67·8	64·9	66·5

* 36 dead and not entered on register as such, 29 prisoners of war, 94 untraced in post, 61 figures lost through bombing or other reasons, 226 returns made but too incomplete to use.

The Results

Before tabulating these returns certain eliminations were deliberately made. To secure a more homogeneous group of "normal" incomes, male principals only were considered, assistants and women being left for separate tabulation. Rather more open to question was the exclusion of 24 practitioners who reported prolonged sickness (2 months or more in any year), and 104 persons who had qualified in medicine at an unusually late age (35 or over), or entered general practice at an unusually late age (45 or over). Both these categories are in a sense "normal", in that they must invariably be present in any medical service. On the other hand what the Spens Committee required were the "normal financial expectations of general medical practice", which I took to mean the customary earnings of a doctor working throughout the year and the progression of those earnings as he moved up the age scale. No exclusions, of course, were made on the plea that the practitioner had just taken over a new practice or just set up in practice. These were regarded as part of the "normal" setting.

A few other omissions had also to be made—of practitioners who moved from one category to another during the year, e.g. from single-handed to partnership, in such a way that no annual figures could be calculated or allocated to an appropriate group, or who were in unusual circumstances, e.g. some arrangement between father and son, husband and wife.

As a result of these eliminations the tabulations for men (principals) in general practice, single-handed or partnership, related to 2,231 gross incomes in the year 1936, 2,317 in 1937 and 2,376 in 1938, a total of 6,924 incomes. Owing to a few lacunae the net incomes numbered 6,902 and the expenses ratios related to 6,915 incomes. This was clearly an impressive body of data—if one could be satisfied that it was reliable.

1951]

BRADFORD HILL—*The Doctor's Day and Pay*

21

I set out the main data in Tables 12 to 16 (those who would seek more detail, e.g. comparisons between the urban and rural doctor, will find it in the *Report of the Inter-Departmental Committee on Remuneration of General Practitioners*, Cmd. 6810, H.M.S.O., 1946). I have refrained from giving a figure for all ages, since the absence of those dying between 1938 and 1945 may well have distorted the age distribution. Except perhaps at ages 65 and above I do not, however, see why their absences should seriously affect the distribution of incomes *within* an age-group (or should be sufficient in number to do so). It will be seen that the main feature of that distribution, whether of gross or net incomes, is its enormously wide scatter. A second point that may be noted is that of the gross income 37·4 per cent. on the average was swallowed up by expenses. 39·4 per cent. of the income at this time was derived from national health insurance (this could be measured on the single-handed only).

TABLE 12

Gross Incomes in 1936-38 of General Practitioners. MEN

(Principals Only, Single-handed or in Partnership)

Income	Ages				
	65 and above	55-64	45-54	35-44	34 and below
£					
0-	6	1	1	..	4
200-	16	9	8	11	19
400-	32	39	25	28	36
600-	60	60	55	71	67
800-	40	69	81	174	165
1,000-	49	66	130	234	191
1,200-	54	99	160	316	242
1,400-	23	90	146	337	181
1,600-	25	101	179	350	124
1,800-	23	85	163	243	115
2,000-	14	65	137	238	70
2,200-	23	63	101	205	49
2,400-	4	51	107	138	28
2,600-	9	28	75	108	32
2,800-	3	27	32	67	22
3,000+	3	56	157	172	37
Total	384	909	1,557	2,692	1,382
Percentage Number of Incomes in Given Ranges					
Under 600	14·1	5·4	2·2	1·4	4·3
600-	26·0	14·2	8·7	9·1	16·8
1,000-	26·8	18·2	18·6	20·4	31·3
1,400-	12·5	21·0	20·9	25·5	22·1
1,800-	9·6	16·5	19·3	17·9	13·4
2,200-	7·0	12·5	13·4	12·7	5·6
2,600+	3·9	12·2	17·0	12·9	6·6
Total	99·9	100·0	100·1	99·9	100·1
Mean Income	1,254	1,703	1,907	1,809	1,484
Median Income	1,159	1,646	1,794	1,701	1,373

TABLE 13

Net Incomes in 1936-38 of General Practitioners. MEN
(Principals Only, Single-handed or in Partnership)
Ages

Income	Ages				
	65 and above	55-64	45-54	35-44	34 and below
£					
0-	31	12	11	14	26
200-	54	81	62	78	59
400-	79	100	134	192	172
600-	66	109	192	372	300
800-	53	147	243	482	279
1,000-	46	122	232	445	231
1,200-	19	117	190	377	112
1,400-	18	82	155	315	81
1,600-	7	60	118	141	43
1,800-	6	30	75	98	34
2,000-	2	14	55	66	16
2,200-	..	14	30	43	7
2,400-	..	7	20	22	5
2,600-	..	4	8	15	3
2,800-	..	5	10	11	2
3,000+	2	5	19	15	..
Total	383	909	1,554	2,686	1,370
<i>Percentage Number of Incomes in Given Ranges</i>					
Under 400	22.2	10.2	4.7	3.4	6.2
400-	37.9	23.0	21.0	21.0	34.5
800-	25.8	29.6	30.6	34.5	37.2
1,200-	9.7	21.9	22.2	25.8	14.1
1,600-	3.4	9.9	12.4	8.9	5.6
2,000+	1.0	5.4	9.1	6.3	2.4
Total	100.0	100.0	100.0	99.9	100.0
Mean Income	752	1,071	1,201	1,157	951
Median Income	686	1,011	1,117	1,092	892

TABLE 14

The General Practitioner's Practice Expenses in 1936-38 as Percentage of his Gross Income. MEN
(Principals only, single-handed or in partnership distinguishing those with and without assistant(s))

Expenses as % of Gross Income	Gross Incomes									
	Under £1,000		£1,000-£1,499		£1,500-£1,999		£2,000+		All Incomes	
	With Asst.	No Asst.	With Asst.	No Asst.	With Asst.	No Asst.	With Asst.	No Asst.	With Asst.	No Asst.
Under 10	1	10	..	5	..	3	..	8	1	26
10- . . . . .	..	61	1	83	5	75	8	79	14	298
20-	2	195	15	404	25	448	108	425	150	1,472
30-	7	277	37	695	88	588	262	464	394	2,024
40-	6	250	25	416	72	321	263	210	366	1,197
50-	2	130	16	153	45	78	145	79	208	440
60-	2	79	10	44	20	22	39	11	71	156
70+	2	46	4	19	4	3	19	1	29	69
Number of incomes	22	1,048	108	1,819	259	1,538	844	1,277	1,233	5,682
Percentage distribution										
Under 10	4.5	1.0	..	0.3	..	0.2	..	0.6	0.1	0.5
10- . . . . .	..	5.8	0.9	4.6	1.9	4.9	0.9	6.2	1.1	5.2
20-	9.1	18.6	13.9	22.2	9.7	29.1	12.8	33.3	12.2	25.9
30-	31.8	26.4	34.3	38.2	34.0	38.2	31.0	36.3	32.0	35.6
40-	27.3	23.9	23.1	22.9	27.8	20.9	31.2	16.4	29.7	21.1
50-	9.1	12.4	14.8	8.4	17.4	5.1	17.2	6.2	16.9	7.7
60-	9.1	7.5	9.3	2.4	7.7	1.4	4.6	0.9	5.8	2.7
70+	9.1	4.4	3.7	1.1	1.5	0.2	2.2	0.1	2.3	1.2
Total	100.0	100.0	100.0	100.1	100.0	100.0	99.9	100.0	100.1	99.9
Mean percentage	44.0	41.3	42.8	37.0	42.8	34.6	42.5	33.4	42.6	36.3

TABLE 15

The Proportion of the General Practitioner's Total Income in 1936-38 that was Derived from National Health Insurance. MEN
(Principals and single-handed only)

	Percentage Derived from N.H.I.	Absolute Numbers of Incomes with given % N.H.I.	Percentage distribution
Under 5		35	1.0
5-		214	6.4
15-		439	13.1
25-		676	20.1
35-		792	23.6
45-		623	18.5
55-		333	9.9
65-		151	4.5
75-		78	2.3
85+		19	0.6
Total		3,360	100.0
Mean %		39.4	

TABLE 16

Details of the Gross and Net Incomes of £3,000 per Annum or Over as Shown Briefly in Tables 12 and 13

Income £	Ages				
	65 and above	55-64	45-54	35-44	34 and below
	Number of gross incomes				
3,000-	1	38	78	86	26
3,500- . . . . .	..	14	41	48	5
4,000- . . . . .	..	2	21	28	4
4,500-	2	2	7	6	2
5,000- . . . . .	..	..	6	4	..
5,500- . . . . .	..	..	1	..	..
6,000- . . . . .	..	..	1	..	..
6,500-7,000 . . . . .	..	..	2	..	..
	Number of net incomes				
3,000-	2	2	12	13	..
3,500- . . . . .	..	3	3	2	..
4,000-4,500 . . . . .	..	..	4	..	..

The Question of Bias

Leaving the statistics to speak for themselves I pass to the fundamental question—were the returns biased? It will be remembered that only two-thirds, or slightly less, of those required were in the end obtained. In putting the material before the Spens Committee I had, therefore, to say that while I believed it would give them “useful statistical information on the pre-war situation”, I could not “lay before it tables about which I can say firmly that they give a precise and exact picture of those pre-war years”. Looking at it now afresh there are, I think, one or two points which are suggestive. The highest component of the lapses was neglect to answer—907 cases in all. This form of lapse rate was not related to age, but remained virtually the same as age rose (see Table 11). If, as was suggested by one critic, doctors with *small* incomes deliberately chose not to answer, fearing to prejudice the picture of pre-war earnings upon which their future remuneration was to be based, then I think one might have expected a higher lapse rate in the age-groups at the two ends of the scale. For in these age-groups incomes are generally lower than at the middle ages (Tables 12 and 13) and would therefore call for a higher rate of concealment.

The rate of refusal to co-operate, on the other hand, does rise with age. It might be expected to do so on the grounds that older persons would be more averse than the younger to a new medical service. But I would hazard the guess that successful persons would be more averse to a change than the unsuccessful! So this refusal rate may tend to conceal relatively high incomes. Figures lost through bombing would tend to be from urban areas, and urban incomes were generally higher than rural.

One reason for these many lapses was undoubtedly the fact that at the time of inquiry at least a thousand of the doctors approached were still in the fighting forces. They were sent forms of authorization to send to partners, wives, accountants or legal representatives authorizing the latter to make a return of their pre-war income. But without any motive or bias many, clearly, would not be expected to take such extra trouble. So long as the figures are confined to age-groups and not amalgamated I do not see why such losses should introduce particular errors. Lastly, there is perhaps an orderly progression of the figures from age-group to age-group, (see, for instance the percentages of Table 13) which bespeaks a reasonable accuracy.

Some of this is, I fear, wishful thinking. There can be no firm answer, but in conclusion there are two points of some importance that I would make. The Spens Committee were “unanimous

in holding that the percentages of low incomes are too high", and it had "no doubt that low incomes have, in fact, been a source of grave worry to many general practitioners and must have prejudiced their efficiency". The Committee, therefore, made proposals to rectify this situation and to increase the doctors' remuneration. But if there were truth in the criticism that doctors with low incomes specially tended to withhold information, then the picture of the past placed before the Spens Committee was too favourable. A representative picture might have led them to propose a still greater degree of amelioration for the future (but in fairness I must admit that the Committee "accepted the figures as sufficiently accurate for our purpose"). The second point is a corollary. If doctors with small incomes deliberately withheld information, fearing to prejudice the future, how greatly they erred! Let it be a warning to all who neglect for ulterior motives to return their questionnaires.

The Global Sum

Arising out of this inquiry into the income of the general practitioner one further sum of considerable importance had to be made. With the advent of the New Health Service the Government proposed to abolish the buying and selling of practices. For the purposes of compensation an estimate had to be made of the aggregate capital value involved. It was finally placed at £66,000,000 (on the assumption that 17,900 principals would enter the service). The first step in reaching this sum was the calculation of the total gross income of practitioners in 1938. Subsequent steps were the number of years' purchase applicable to that value, and the use of a "betterment" factor to take into account the increased values between 1938 and 1946. With these I was not directly concerned.

In the pre-war inquiry into the services given by insurance practitioners it had been estimated that the total number of principals on the medical lists was 17,734. Of the 6,000 drawn at random and approached a small number (1.5 per cent.) had proved not to belong to the class defined. On the other hand, there must have been a number of practitioners engaged in private practice only. The remuneration inquiry indicated that these were likely to be few, for of single-handed practitioners only 1 per cent. had a ratio of N.H.I. income to total income of less than 5 per cent. Making slight adjustments for these two factors gives an estimate of 17,648 principals engaged in practice pre-war. Of this total some unknown number had died between 1938 and 1945 when the remuneration inquiry was made. Using the death-rates of physicians and surgeons (not all of whom would, of course, be in general practice) as published by the Registrar-General in his Occupational Mortality Supplement of 1930-32, I estimated the annual death-rate at 25 per 1,000 for ages under 70. At this death-rate there should have been 2,866 deaths in the seven-year interval, and the number left on the sampled live register would have been 14,782.

This estimated total of 14,782 principals in practice in 1938 and surviving in 1945 were divided by sex and age (six groups) and the men by type of practice (urban, rural or mixed) on the basis of the distribution found in the remuneration inquiry (i.e. on the basis of those who answered, and as men over 65 did not answer as frequently as younger men some error is here introduced). To each of these twenty-four sub-groups was then allotted the appropriate average income as revealed by the sample inquiry. The resulting total income was a fraction under £25,000,000. To this had to be added the earnings of the estimated 2,866 who had died. These persons were first distributed to age groups in the proportions shown by the Registrar-General in his 1930-32 occupational mortality figures, and then to the sex and type-of-practice groups in the ratios shown by the remuneration inquiry. Allotted the mean income of their resulting group gave total earnings of slightly over £4,000,000, and a total for all principals in 1938 of £29,000,000.

This figure might, I think, be somewhat too high since too few persons were put in the oldest age-group (the differential no-answer rate in the sample inquiry having been ignored) and the observed average incomes were applied to the sick, late entries to practice and to those dying. But the main criticism is, of course, that the average incomes used were derived from the two-thirds who returned their questionnaires, and one has to presume they were representative.

Fortunately a second approach was possible. The gross annual payment made to general practitioners under the N.H.I. scheme was known accurately for the pre-war years. What was not known was the amount of income derived from private practice. In the remuneration inquiry single-handed practitioners had been asked what proportion of their total income came from N.H.I., and combining men and women and all types of practice the average figure was 38.7 per

cent. It was, however, impossible to put this question to practitioners in partnership, since the inquiry required *individual* incomes, and it is not always possible for the individual in a partnership to give the specific N.H.I. component. It was known that the ratio in partnerships was likely to be rather less than with the single-handed, but the only figures available related to a small inquiry that had been made in one county. Here the proportion of total income derived from N.H.I. was 32·14 per cent. for 33 single-handed practitioners and 25·76 per cent. for 41 practitioners working in partnership. The former figure clearly does not differ significantly from the 38·7 per cent. derived from the main inquiry. The best one can do in the circumstances is to accept this figure of 38·7, which has a substantial basis, for the single-handed, and make the distressingly bold assumption that the relative position of the single-handed to the partners is in the ratio of 32·14 to 25·76, as revealed by the local inquiry. On this most unsubstantial basis the overall figure for partners would be 80·15 per cent. of 38·7, or 31·0. Weighting these two figures, 38·7 and 31·0, by the relative numbers of practitioners working single-handed and in partnership gives 34·6 per cent. as the estimate of the proportion of total income derived from N.H.I. The average annual amount of money paid under N.H.I. in 1936–38 (in Great Britain and Northern Ireland) was, I was advised, £9,190,000. If this represented 34·6 per cent. of the total gross income the latter would have been £26,560,000.

The weakness here clearly lies in the absence of a really firm figure for the ratio of N.H.I. to total income. The two estimates reached by entirely different routes differ, however, by only 9 per cent. Taking the mean between the two gives a total of £28,000,000 gross income, and this was the figure adopted in the subsequent calculations of compensation. With some 17,650 principals it implies an average gross income of slightly less than £1,600 per annum, or, deducting practice expenses, a net income of about £1,000 in the immediate pre-war years.

Summary of the Income of the General Practitioner

(1) A one-in-four sample of general practitioners was asked in 1945 to supply a record of their income and practice expenses, as returned for income tax, in the years 1936, 1937 and 1938.

(2) The sample, of necessity, excluded those in practice in the pre-war years who had subsequently died; of the survivors who were approached only approximately two-thirds replied.

(3) For these reasons the available sample is open to grave doubt, and is almost certainly in error in its age distribution. There is, however, less reason to suppose that the data *within* an age-group are seriously biased, and some slight suggestions in support of this conclusion are revealed in the figures.

(4) Allowing for the dead the total annual pre-war income of general practitioners (principals only) is calculated at £28,000,000, giving a gross income of nearly £1,600 per principal. Practice expenses were, on the average, nearly 37½ per cent. of the gross income, and the average net income was, therefore, approximately £1,000 per annum.

(5) The distribution of incomes was very widely scattered at each age, and even at the ages of maximum earning capacity (35 to 54) 42 per cent. of the net incomes recorded were less than £1,000 per annum.

III. THE INCOME OF THE SPECIALIST

Following hard upon the heels of the first "Spens Committee" came the second. It was charged with the problem of considering "what ought to be the range of total professional remuneration of registered medical practitioners engaged in the different branches of consultant or specialist practice in any publicly organized hospital and specialist service", and it was instructed to consider this with, amongst other matters, "due regard to what have been the financial expectations of consultant and specialist practice in the past". Factual information on the past was, therefore, once again an essential requirement. A fundamental difficulty at the outset, however, was that there existed no list of the persons who were engaged before the war exclusively or predominantly in consultant or specialist practice, and there appeared to be no way of constructing one. No sample could be drawn, for there was no known "universe" from which to draw it. In this impasse the procedure adopted to reach the relevant persons was as follows:

(a) Through the Central Bureau of Hospital Information the Secretaries of all voluntary hospitals in England, Scotland and Wales were asked to supply, from the hospital's records,

the names of all members of "selected" part-time visiting staffs during 1938-39 (as distinguished from "open" staffs, to which all local practitioners are appointed solely by virtue of their being in practice in the neighbourhood). These returns were obtained from all hospitals, so no losses occurred here.

(b) Through medical officers of health the names of specialists on the part-time visiting staffs of local authority hospitals were obtained. The response was again complete.

(c) These two sources produced 6,868 names relating to the year 1938-39, but of this total 870 were known to have died and the addresses of 15 could not be discovered, leaving 5,983. (A further 36 were subsequently discovered to have died.)

(d) It was known that some large proportion of these 5,983 persons would not, in fact, be consultants or specialists at all but be predominantly in general practice. As, however, there was no possible way of centrally identifying these two groups a form was sent to every person, and upon this the recipient was asked to declare (1) that he, or she, was *not* engaged predominantly or exclusively in consultant or specialist practice in 1938-39 and was, therefore, not relevant to the inquiry, or (2) that he, or she, *was* predominantly or exclusively in consultant or specialist practice—and in all such cases a return of the 1938-39 income was requested.

By these means, in the absence of a defined "universe", the attempt was made to identify and obtain income figures from *all* those who were in consultant or specialist practice in 1938-39 and were still alive in 1947 (whether still in practice or retired).

Precautionary Measures

In the previous inquiry into the incomes of the general practitioner two of the several reasons contributing to the relatively poor rate of return of the questionnaires were, I suspected, (a) a lack of complete secrecy in the return—the doctor had to sign his form, though his name was removed immediately upon its receipt, and (b) a lack of time enforced by circumstances—that bugbear of all accurate statistical work—for a persistent follow-up of the many who had not answered. Given time more answers could have been secured, possibly many more. In the present inquiry it would clearly be wise to overcome, as far as possible, both these drawbacks.

The former was dealt with in the following way: Two forms attached to one another were sent to each person on the list. Form A contained the fundamental questions on income, professional expenses, nature of specialist practice followed and similar details. It was to be detached and returned *unsigned* (in Envelope A provided) direct to me at the London School of Hygiene and Tropical Medicine. The recipient's attention was specially drawn to this in a covering letter, which stated "you will see that Form A does not contain your name, nor any space provided for your signature, nor any number by which you can be identified. The statistician will not know who has sent him this form. It will be seen only by him and by his computing clerks, and neither he nor they will have any interest in or means of discovering your identity". On the other hand, it was essential to know which of the recipients had responded to the call so that they might not be "dunned" again. Form B therefore was a *signed* declaration that Form A had been returned to me and contained a correct return of income (or that the doctor was not a specialist in the year in question and therefore not relevant to the inquiry). This form was sent (in Envelope B) direct to the Committee concerned with the inquiry at B.M.A. House. The two forms could not be brought together, and absolute secrecy was thereby ensured. One obvious drawback of the method was that no action could be taken to clear up any ambiguities in the income return—and only those who have dealt with questionnaires can realize how many *very* odd and obscure answers can be given. This also was stressed in the covering letter, but the technique certainly created some difficulties.

Even under these conditions of secrecy a 100 per cent. response was out of the question, and if, as was possible, between one and two thousand doctors failed to answer, a persistent follow-up would be impossible. It would, however, be quite easy to be extremely persistent with a small but representative sample. Such a sample, if complete returns could be secured for it, would serve, when separately analysed, as a check upon the large but incomplete mass of returns. It would reveal whether the latter were biased, and if so, in which direction. It was, of course, easy enough to draw a sample from the 5,983 forms to be despatched, and subsequently to see how

many made a return and develop a follow-up. But in view of the secrecy proviso there was no way in which I should be able to sort out and analyse separately their income returns. Some dodge had to be incorporated to overcome this difficulty. The one I adopted was this : At the bottom of Form A appeared a not unusual instruction to the reader which the printer had set as [P.T.O. In 10 per cent. of the forms the square bracket was, at my request, omitted, and such a "marked" form was sent to every tenth doctor upon the list which had been constructed, i.e. to 598 persons out of the total 5,983.

I need hardly point out that this device in no way departed from the principle of absolute secrecy which it was promised to observe. The names in the sample, as in the main group, were known to the Secretaries of the Committee, but they saw no income returns. The income returns from members of the sample could be identified by me as belonging to the required group, but I knew nothing about their identity and did not need to. I had merely to identify a *group* within the total.

The Response

The response to the 5,983 forms sent out was as follows: As stated above 36 were found to have died. From the 5,947 who, so far as was known, were still alive, answers on Form B were received from 4,793, or a fraction over 80 per cent. Of these approximately half (2,349) declared that they were not engaged predominantly in consultant or specialist practice and were, therefore, not relevant to the inquiry. 2,364 declared that they were in such practice and had made the required income return. The remaining 80 appeared to be within the scope of the inquiry but stated that they were unable or unwilling to make the required return, e.g. their records had been lost or destroyed. In fact I myself received rather more than the reported 2,364 returns, namely 2,420; presumably a few had neglected to return form B. On the other hand analysis showed that 306 of the income forms returned to me did not fall within the definition of specialist or consultant laid down—some were in whole-time salaried posts, some had retired from practice before 1938, while over half said they were not in fact engaged exclusively or predominantly in consultant or specialist practice (although they had made an income return). Thus:

Income returns received	2,420
„ „ „ but not applicable	306
Total applicable returns	2,114
Returns eliminated on account of prolonged absence (3 or more months) from practice in year in question	22
Returns lacking necessary particulars	73
	<hr/>
	2,019

From the nature of the inquiry, as specified above, it was impossible to calculate the proportion of the required returns that were in fact received. The "universe" was not known, and so there was no readily available information about the 1,154, or 20 per cent., who had made no response. Presuming—somewhat boldly—that there was in them the 50:50 ratio of specialist to non-specialist that existed in the 80 per cent. who had replied, one would have (a trifle roughly, but sufficient for the purpose) the following ratio: 2,019 tabulated returns/2,019 + 80 declined + 73 unusable + 580 no answer and all presumed applicable or, in other words, slightly under three-quarters of the required forms were received (from 1,923 men and 96 women).

The special sample can provide some check. Of 598 persons in this group, 8 were found to have died. Of the remaining 590 some reply was received from 518, or from nearly 88 per cent. Amongst these 518 doctors there were 268 specialists and 250 general practitioners or other irrelevant categories, i.e. 52 per cent. were specialists. In the main inquiry of 4,983 answers 2,444 were specialists (2,364 returns and 80 refusals), or 51 per cent. of those answering. Sample and main inquiry agree. But with the sample a further step was practicable. Information about every one of the 72 persons who had made no reply was extracted from the Medical Directory and also from the pre-war register of the Central Medical War Committee. On the basis of this information they were divided into the two groups, (a) almost certainly a specialist in 1938-39, and (b) almost certainly not a specialist. The ratio proved to be 35 a's to 37 b's, that is, nearly

1951]

29

49 per cent. were classified as specialists. It therefore seems likely that the assumption that the 20 per cent. not answering in the main inquiry were equally composed of specialists and non-specialists was not so unduly bold, and accordingly that rather less than 75 per cent. of the required returns were received.

These somewhat tedious calculations are important, since much turns upon the response rate. Although it was, no doubt, good for this type of inquiry, the very probable absence of at least one-quarter of the required returns is clearly a serious matter, and too large a proportion to allow one to maintain confidently that the large body of data collected must give a representative picture of the pre-war incomes. Hence the importance of the sub-sample—if it were successfully obtained. The fact that the dead are missing should also be remembered. For this reason I have, once more, avoided giving all-age figures, since the age distribution of the population must inevitably be distorted.

The Results

In Tables 17 to 20 some results of this inquiry are briefly set out (the net incomes are given in detail for each medical specialty in the *Report of the Inter-Departmental Committee on the Remuneration of Consultants and Specialists*, Cmd. 7420, H.M.S.O., 1948). I regret that it is

TABLE 17

*Gross Incomes in 1938-1939 of Consultants and Specialists. MEN**

Gross Income £	Ages				
	60 and above	55-59	45-54	35-44	34 and below
0-	32 (9)	16 (1)	12 (2)	52 (6)	68 (15)
1,000-	41 (15)	48 (13)	108 (24)	165 (33)	82 (17)
2,000-	32 (6)	52 (8)	112 (36)	150 (40)	51 (10)
3,000-	25 (3)	25 (2)	78 (13)	128 (14)	17 (5)
4,000-	8 (1)	20 (1)	61 (5)	38 (4)	8 (2)
5,000-	6	4	35 (2)	27 (4)	..
6,000-	5	3 (1)	17 (2)	19 (1)	2
7,000-	1	3	15	10	..
8,000-	1	3	9	6	..
9,000-	..	1	6	2	..
10,000+ †	1	3	10	8	..
Total	152 (34)	178 (26)	463 (84)	605 (102)	228 (50)
Percentage number of incomes in given range					
Under 1,000	21.1	9.0	2.6	8.6	29.8
1,000-	27.0	27.0	23.3	27.3	36.0
2,000-	21.1	29.2	24.1	24.8	22.4
3,000-	16.4	14.0	16.8	21.2	7.5
4,000-	5.3	11.2	13.2	6.3	3.5
5,000+	9.2	9.6	20.1	11.8	0.9
Total	100.1	100.0	100.1	100.0	100.1
Mean Income	2,457	2,994	3,597	2,934	1,724
Median Income	2,125	2,500	3,006	2,570	1,573

* The figures in bold type relate to men exclusively engaged in consultant or specialist practice; those in italics and brackets to men predominantly engaged in such practice. The percentages and averages relate solely to the former group.

† With the following distribution at all ages: 7 at 10-11, 6 at 11-12, 1 at 12-13, 2 at 13-14, 3 at 14-15, 1 at 15-16, 1 at 16-17 and 1 at 21-22. The figures in the age groups cannot be given since with such small numbers identification of individuals might be possible within the profession.

not possible to cast these tables in precisely the same form as Tables 12 to 16 relating to the incomes of general practitioners. This comparability was not required at the time of the inquiry, and unfortunately is not possible now. The numbers may differ slightly in the present tables owing to lacunae in the returns. The few women specialists are excluded (some data were published in the Inter-departmental Committee's report). Table 17 gives particulars of the gross incomes of two groups, those who said they were *exclusively* engaged in specialist or consultant practice, and those who said they were *predominantly* so engaged. The latter was a relatively small group (about one-sixth of the total number), and not wholly applicable to the problem under study. Tables 18, 19 and 20 are, therefore, limited to those exclusively engaged in consultant or specialist practice.

As would be expected, and was found with the general practitioners, there is an exceedingly wide scatter in the gross and net incomes. Perhaps rather less expected are the actual proportions with low and high incomes. Taking the net figures of Table 18 it will be seen that at the peak of the specialist's earning capacity—ages 45–54—nearly one-third had, after the deduction of practice expenses, a pre-war income of under £1,500. At the other end of the scale there were clearly glittering prizes to be won. But not, it seems, by so very many. At the ages of 45–54 there was one in six with a net income of £4,000 or more; at all ages combined only 10 had a net income of over £10,000. Relatively speaking, however, our hearts need not bleed. At the most “productive” ages of 35–54 less than 10 per cent. of general practitioners had a net income of £2,000 or above; very nearly half the specialists reached that level.

TABLE 18

Net Incomes in 1938–39 of Consultants and Specialists (Exclusively Engaged in such Practice). MEN

Net Income £	Ages				
	60 and above	55–59	45–54	35–44	34 and below
0–	25	10	12	34	45
500–	30	31	48	85	61
1,000–	24	31	86	113	57
1,500–	18	37	78	109	32
2,000–	16	20	57	82	14
2,500–	12	19	39	71	11
3,000–	5	6	43	36	5
3,500–	7	6	20	22	0
4,000+	10	18	81	52	2
Total	147	178	464	604	227
Percentage number of incomes in given ranges					
0–	17.0	5.6	2.6	5.6	19.8
500–	20.4	17.4	10.3	14.1	26.9
1,000–	16.3	17.4	18.5	18.7	25.1
1,500–	12.2	20.8	16.8	18.0	14.1
2,000–	10.9	11.2	12.3	13.6	6.2
2,500–	8.2	10.7	8.4	11.8	4.8
3,000–	3.4	3.4	9.3	6.0	2.2
3,500–	4.8	3.4	4.3	3.6	0.0
4,000+	6.8	10.1	17.5	8.6	0.9
Total	100.0	100.0	100.0	100.0	100.0
Mean Income	1,739	2,160	2,568	2,119	1,202
Median Income	1,450	1,750	1,960	1,798	1,050

TABLE 19

The Consultant and Specialist's Practice Expenses in 1938-39 as Percentage of His Gross Income. MEN

(Exclusively Engaged in such Practice)

Expenses as % of Gross Income	Under £1,000	£1,000- £1,999	£2,000- £2,999	£3,000- £3,999	£4,000 and Over	All Incomes
5-	21	30	23	14	33	121
15-	35	132	114	98	117	496
25-	36	140	150	97	100	523
35-	33	65	71	42	59	270
45-	16	38	25	17	17	113
55-	16	17	5	2	5	45
65-	8	8	2	3	..	21
75+	13	8	..	1	..	22
Number of incomes	178	438	390	274	331	1,611
Percentage distribution						
5-	11.8	6.8	5.9	5.1	10.0	7.5
15-	19.7	30.1	29.2	35.8	35.3	30.8
25-	20.2	32.0	38.5	35.4	30.2	32.5
35-	18.5	14.8	18.2	15.3	17.8	16.8
45-	9.0	8.7	6.4	6.2	5.1	7.0
55-	9.0	3.9	1.3	0.7	1.5	2.8
65-	7.3	1.8	0.5	1.1	..	1.3
75+	4.5	1.8	..	0.4	..	1.4
Total	100.0	99.9	100.0	100.0	99.9	100.1
Mean percentage	39.5	31.6	29.6	29.0	27.7	30.7

TABLE 20

Details of the Net Incomes of £4,000 Per Annum or Above as shown Briefly in Table 18

Income	Ages				
	60 and above	55-59	45-54	35-44	34 and below
£					
4,000-	5	8	37	25	1
5,000-	2	4	22	11	1
6,000-	2	1	8	4	..
7,000-	..	1	8	7	..
8,000-	1	..	3	2	..
9,000-	..	..	..	..	..
10,000+*	..	4	3	3	..
Total	10	18	81	52	2

* With the following distribution at all ages: 4 at 10-11, 3 at 11-12, 2 at 14-15 and 1 at 15-16. The figures in the age-groups cannot be given since with such small numbers identification of individuals might be possible within the profession.

The Sample Inquiry

The final point to be considered is whether the device of the sample inquiry within the main inquiry was sufficiently successful to give evidence of bias or no bias in the 75 per cent. response that had been obtained in the main inquiry. The analysis may be confined, for reasons already given, to men exclusively engaged in consultant or specialist practice and to their net incomes. The marked sample of 598 had produced 208 such persons; of these, 169 had made returns which could be tabulated, and 39 had either made no reply or sent a useless reply. Persistence (including signed letters from high dignitaries) had somewhat increased the rate of response, but not to the extent hoped—from the estimated 73 per cent. in the total to the 83 per cent. here.

The characteristics of the no-response group in the sample could, as previously stated, be derived or assessed from available records (this, of course, *could* have been carried out for the total, but only at the expense of very great and expert labour). Table 21 compares one of these characteristics—the nature of the specialty practised—between the main inquiry and the sample. As would be expected, the distribution in the 169 in the sample who answered is very similar to that of the 1,620 in the main group who answered. When those in the sample who did not answer are added in the distribution is not materially altered. In other words, there is no evidence in the sample that one specialty rather than another was particularly unwilling to reply. The similarity of the distributions also makes it possible to compare the sample with the main inquiry without differentiation by specialty.

TABLE 21

Percentage Distribution of Specialists Exclusively Engaged

<i>Nature of Specialty</i>	<i>Main Group</i>	<i>Sample</i>	<i>Sample</i>
	(1,620 men)	Answering (169 men)	including those not Answering (208 men)
Surgery	23	27	26
Medicine	18	15	15
Ophthalmology	15	13	14
Ear, nose and throat	10	10	11
Gynaecology	8	6	7
Radiology	8	11	10
Anaesthetics	5	5	5
Dermatology and psychiatry	5	5	5
Orthopaedics	4	4	3
Pathology	4	4	4
Total	100	100	100

A second characteristic—age—is examined in Table 22. It is clear that refusal (or inability) to answer was pronounced in the oldest age-group, 60 and over, in which nearly half the returns were missing. Remembering also the absence of the dead, the figures at these ages may well be regarded as unreliable. On the other hand at the important ages of 35–49 nearly 90 per cent. of the required returns were received.

TABLE 22

Age Distribution of Returns and No-returns in Sample

<i>Age</i>	<i>Total Number in Sample</i>	<i>Number not Answering</i>	<i>Percentage not Answering</i>
Under 35	35	7	20.0
35–39	45	5	11.1
40–49	55	1	12.7
50–59	49	9	18.4
60+	24	11	45.8
All ages	208	39	18.7

Eliminating these persons of 60 years of age or more the average net income figures for sample and main group are compared in Table 23. It will be seen that for those who answered (lines (a) and (b)) there is substantial discrepancy between the main group and the sample only at ages 40-49, where the sample shows a relatively high average income. In total the mean incomes are extremely close (£2,125 and £2,176), and at the particular ages 40-49 the medians are not far apart (£2,050 and £2,200). It seems, therefore, that sample and main group are very similar and, as a corollary, that the 10 per cent fewer returns obtained in the latter was not a noticeable source of bias.

The source of bias usually suspected is a tendency for high incomes to be returned and low incomes to be left out. As a check upon this I have in Table 23, line (c), included all but three of those in the sample who did not answer *as if they had earned nothing whatever*. The remaining three have been inserted at figures given in their returns, but which were not the required income tax statement. These procedures will indicate the maximum amount by which the recorded figures for the main group might be in error through neglect to answer. At the combined ages it will be seen that the recorded mean might at the most be, roughly, £250 too high, or 13 per cent. in excess of the true figure. At the different ages the possible excess varies between 6 and 21 per cent.

TABLE 23

Mean Net Income in Main Group and in Sample
(In brackets number of men involved)

	Ages				
	Under 35	35-39	40-49	50-59	Total
Main group (a)	£1,202 (227)	£1,951 (358)	£2,500 (489)	£2,347 (399)	£2,125 (1,473)
Sample answering (b)	£1,260 (28)	£1,995 (40)	£2,910 (48)	£2,118 (40)	£2,176 (156)
Sample including no answers* (c)	£1,090 (35)	£1,779 (45)	£2,748 (55)	£1,750 (49)	£1,930 (184)
Excess of (b) over (c)	+£170	+£216	+£162	+£368	+£246
(b) as % of (c)	116	112	106	121	113

* Of the no-answers 3 have been inserted at approximate figures given in their returns (£300, £600 and £2,500) and 25 at no net income at all, i.e. at 0.

Similar calculations were made on the median net income but gave no very different results. At all ages (including here those over 60) the medians were (a) £1,750 in the main group, (b) £1,650 in the sample answering, and (c) £1,500 if 36 of the non-answerers are put at no income at all and the remaining three at their rather rough statements. The excess of (b) over (c) is 10 per cent. In short, this analysis suggests that the recorded *average* net incomes might at the very most be some 10-15 per cent. too high at ages under 60. The real difference must, of course, be less than that, since violence has deliberately been done in giving nearly all the non-answerers no income whatever.

Finally Table 24 makes a comparison between the observed distributions of incomes. With those making returns there is, again, no appreciable difference between the main group and sample. To the nearest whole number 22 per cent. of the main group and 24 per cent. of the sample had "low" net incomes (under £1,000), 58 and 55 per cent. had "medium" incomes (£1,000-£3,000), 20 and 21 per cent. had "high" incomes (over £3,000)—a very satisfactory concordance. Including the non-answerers as before materially, and inevitably, increases the proportion of "low" incomes—from 24 per cent. to 35 per cent. The "medium" incomes fall to 47 per cent. (from 55 per cent.), and the "high" incomes become 17 in place of 21 per cent. In spite of the most unfavourable assumptions made the changes at this end of the scale are not very great.

From this analysis I personally conclude that, in spite of the fact that the response in the sample inquiry was not as near to 100 per cent. as I had hoped, the device was worth while. The analysis of the returns does, I submit, suggest that the figures of the main inquiry can be accepted without serious qualms, in spite of the absence of as many as a quarter of the required returns.

Summary of the Income of the Consultant and Specialist

(1) All persons believed to have been in consultant or specialist practice in the pre-war years were asked to give a return of their income for 1938-39.

(2) Those who had died since that date were necessarily excluded. Of the survivors it is estimated that slightly less than three-quarters responded with an effective return.

TABLE 24

Percentage Distribution of Incomes in Main Group and Sample at Ages Under 60

£'000's	Main Group (1,473)	Sample Answering (156)	Sample Including no Answers*
0-	22.1	24.4	35.3
1-	36.9	35.3	29.9
2-	21.2	19.9	17.4
3-	9.4	9.0	7.6
4-	4.8	5.8	4.9
5+	5.6	5.7	4.8
Total	100.0	100.1	99.9

* See footnote to Table 23.

(3) During the course of the inquiry, in which the return of income was made anonymously to afford absolute secrecy, every tenth form sent out was specially marked. With persistence it was hoped that returns from all this small sample could be obtained, and thus serve as a check upon the possible presence of bias in the main inquiry with its 73 per cent. response.

(4) This device was not wholly successful, but it gave results strongly indicating that the figures derived from the main inquiry could not be seriously at fault.

(5) The distribution of incomes was very widely scattered at each age. Even at the peak of the specialist's earning capacity—ages 45-54—nearly one-third of them had a pre-war net income of less than £1,500 per annum (i.e. after the deduction of practice expenses). At the same ages one in six had a net income of over £4,000 per annum.

CONCLUSION

In conclusion I may recall that I set out upon this address with the noblest intentions, determined to avoid the controversial upon the one hand and the flat and dreary upon the other. I fear, alas, it was an ambition impossible of achievement, for not only was its compass beyond me, but the two aims are not, I believe, compatible. I have no doubt that I have reached conclusions or used methods to reach conclusions from which the reader will dissent; that I have made assumptions at which he will cock an astonished eyebrow. Of the more important issue, the flat and dreary, it is much more difficult for me to judge. When all is said and done, it is my own child, and one's own children are always so *very* different from that horrid little brat next door. That the inquiries, which I have here brought together, fall within a narrow field I fully realize. I was myself interested in their actual content because I have lived all my life with "doctors" and I am interested in their ways of living and thinking. But there is clearly no reason at all why other persons should share that interest. On the other hand, I dared hope that these field inquiries would offer something of *general* interest, and especially in the statistical field of survey work—indeed in its most dangerous and treacherous form, the inquiry by questionnaire. In that hope I trust that I have not wholly misled myself.

PROCEEDINGS OF THE MEETING

Sir GEOFFREY HEYWORTH (Past-President), in moving the vote of thanks: Professor Bradford Hill has reminded the meeting that the Society has a wise rule that there shall be no discussion on the Inaugural Address. Anyway, Professor Hill has little to fear from one who is not a statistician. But although I am not a statistician I will admit to having discussed the paper

with a statistician and with a doctor. As a layman, the outstanding feature which impresses me about the Address is the clarity of its expression. If all statisticians approached the standard of the President in presenting their work, what a help it would be to the layman.

I cannot comment on the techniques described, except to say how impressed I am by the self-criticism evident throughout. If I feel Professor Hill is almost too apologetic about the time which he has spent describing his procedures, it is well to recall "that justice should not only be done, but be seen to be done". I was interested in the method of testing that the doctors were not more zealous in their work when they were recording for the inquiry. This is a problem which is of much interest in other fields, particularly in market research, and the remarks made will help people working in such fields.

The material I found fascinating—and I am left wishing to have the answers to more questions. But Professor Hill rightly forestalled that comment when he said: "A demand for too many golden eggs will almost inevitably lead to an enhanced rate of refusal to co-operate, and to a subsequent lapse rate which will defeat in the end not only this demand but, indeed, the whole inquiry". I am intrigued to find that Monday is not only the day on which the housewife does her washing, but also the day for seeing her doctor—I hope there is no causal connection between the two. It is also interesting to note, under "'Special Services' Rendered per Doctor", that there was an average per week of 34 certificates and 6 reports. A great many people would like to know what the figures are to-day, and the amount of time which the doctor has to spend on clerical work.

When it comes to incomes, I am struck by the small variation shown in the earnings of the medical profession throughout their lives, with a peak at 45/54. That is a very different pattern of earning indeed from the pattern one is used to in the fields of industry and commerce, particularly to find the fall in income after the age of 54, although admittedly this fall is small. The income of workers in industry generally rises continuously, unless perhaps when the doctor has not done his job properly and coronary thrombosis or gastric ulcers or other occupational diseases cut down the income in the last age group! All will be interested in the disparity between the income of the general practitioner and that of the specialist.

There are many other points which might be raised, but their purpose would only be to emphasize how successful the President has been in avoiding the flat and dreary. He has not been more controversial than was needed to provide piquancy for such a substantial dish. I hope that on some future occasion the Society will have an opportunity of hearing Professor Hill discuss the recording of opinion, not of fact as in this case. I feel that Professor Hill would reveal an approach and technique which would add a great deal to the available experience. I have gained much from listening to the present paper.

Dr. DAVID HERON (previous Past-President), in seconding the vote of thanks: I perform this last official act as a Past-President with particular pleasure because Professor Bradford Hill and I have worked together in the Society in the greatest friendship and harmony for many years. Indeed, few Fellows have had so many opportunities as I have had of realizing how large a proportion of his time the President has given to the work of the Society, in spite of the claims of the very active Department of Medical Statistics which he controls. Professor Bradford Hill's election as President recognizes not only his outstanding services to the Society but also his distinction as a medical statistician, on whom the mantle of Major Greenwood has so happily fallen.

When the Bye-Laws of the Society were being revised some years ago, I was able to persuade the committee dealing with the matter, and subsequently the Council and the general body of Fellows, that on the whole it would be in the interests of the Society that the long-standing rule that Presidents were not to hold office for more than two consecutive years should be extended by the introduction of a rule that the other Honorary Officers should not hold office for more than ten consecutive years. I was the more easily able to do so because I was at that time the Honorary Officer with the longest service. I now confess that I had then clearly in mind the hope and expectation that after the maximum of ten years' service as Honorary Secretary, Professor Bradford Hill might immediately afterwards step into the Presidential chair, without any interruption to his work for the Society. I am very glad that my hopes have now been realized.

Professor Bradford Hill assumes office at a particularly difficult time in the history of the Society, when the further development of its work, and particularly its housing and the utilization of the magnificent gift of £30,000 which the Society has received, require urgent consideration and action. Every Fellow will join in wishing the President every possible success during his term of office, and will do all that he can to help the President to ensure this.

All have noticed with pleasure the increasing use which is being made of the knowledge and experience of the President in both official and unofficial enquiries in his special field, and it is therefore entirely appropriate that Professor Bradford Hill should devote his Presidential Address

to a fuller description of the statistical investigations which he carried out on the services rendered and the remuneration received by general practitioners, and on the remuneration of consultants and specialists, which formed the basis of the Spens Reports. His Address provides a very useful supplement to those Reports.

His account of the careful checks he has made on so many aspects of the data is certainly impressive but, without suggesting any criticism of the procedure followed in this investigation, I should like to call attention to three percentages which seem to me to be significant.

It will be seen from Table 1 that 97 per cent. of the first sample, of insurance general practitioners, provided information on services rendered, but that, from Table 2, only 66 per cent. of the second sample of general practitioners gave details of remuneration, while in an attempt to cover the whole field of consultants and specialists, it is suggested with some hesitation on pp. 28-29 that rather less than 75 per cent. provided usable data on remuneration.

It is doubtful whether any voluntary enquiry on incomes could be expected to give better results, especially when, as so often happens, it is not quite clear whether it is to the advantage of the individual or his group to exaggerate or to understate earnings. The President has given a very useful warning of the danger of failing to play ball with the enquiring statistician.

This gives me an opportunity of riding one of my hobby-horses in asking why Income Tax returns should not be used in such investigations. I do not for a moment suggest that the American practice should be followed of publishing details of individual returns, by which the earnings of film stars and motor magnates become front-page news once a year, but I do think that there are fewer objections to the publication of tables showing the incomes, and particularly the earned incomes, of selected groups or occupations, in much the same way as details of occupational mortality are published. At the present rate of tax, incomes are unlikely to be overstated, and if in any group there is systematic understatement of earnings in Income Tax returns, then it will be only rough poetic justice to ignore the understatements in such enquiries as those described in the Address.

Finally, I assure the President that there is nothing in the Bye-Laws of the Society to prevent him from giving, in due course, a valedictory Address.

The vote of thanks was carried unanimously. The President in acknowledging it recalled that some years before the war he had made an analysis of attendances at the Society's meetings in relation to the subject matter of the paper read. Times had changed, for mathematical statistics then came last on the list. Medicine was also low and to ensure a bumper attendance one had to talk on finance or economics. But he had found also that he had wholly to exclude from the analysis every Presidential Address. It was clearly traditional that a large number of Fellows would go to listen to this whatever the subject matter—or perhaps it would be more accurate to say, it was traditional to go to it. He was deeply grateful to Fellows for so nobly upholding the tradition on the present occasion. Not only, too, was he fortunate in being spared from the cut-and-thrust of the Society's ordinary meetings but he was even more fortunate in having as his predecessors in office, two persons who were so skilled in saying the nicest, if the most embarrassing, things. He acknowledged with much gratitude the very kind remarks made by Sir Geoffrey Heyworth and Dr. David Heron and the acceptance of them by the meeting.

As a result of the ballot taken during the meeting, the candidates named below were elected Fellows of the Society:

Christopher Richard Baines
Anthony Gordon Baker
Barbara Joan Banks
Albert Battersby
Walter Benjamin
Narbheshanker M. Bhatt
Edwin Ernest Blandon
Lucy Block
Phillip Anthony Borman
John Truesdale Boyd
Marion Irvine Brown
William Dennis Burrowes
Norman James Campbell
Monica Anne Creasy
Harold Percy Dainton
Conrad Francis Dehn

Ianthe Dingwall-Fordyce
James Alexander Thomas Douglas
Roger David Elston
Leslie Francis Emblem
Richard William Evelyn
William David Ewan
Ernest Arthur Field
Joseph Flemhood
Douglas Henry Foxall
James Campbell Fraser
Robert Félix Henri Girschig
James Eric Hailstone
John Leslie Harris
Norman Henry Hayes
Michael Anthony Heasman
William Francis Hood

Margery E. Hosker
 Jean Florence House
 David Graham Hutton
 Donald Morton Iles
 Robert Francis Innes
 Stanley Neville Johnson
 Margaret Johnston
 Ena Agnes Knight
 John Laing
 Bernard Landsman
 Frank Arthur Long
 William Douglas McClelland
 Leonard Patrick Matthews
 Florence Edith Mercer
 Donald Owen Mills
 William Joseph Murch
 Frank Joseph Nash
 Charles Frederick Naylor
 Edward Bennet Neame
 Colin Nuttall

Gail Barker Oakland
 Peter Maurice Payne
 Ian Falconer Peet
 Norman Littlejohn Philip
 Henryk Stefan Polanski
 William Graham Rogers
 William St. Clair Russell
 Leonard Roy Shenton
 Gordon Sinkinson
 Paul Anthony Crofton Sleight
 Anthony Robert Smith
 Oliver Douglas Smith
 Ashley Bertrand Spence
 Ian David Whyte
 Evan James Williams
 John Keith Rainbird Wood
 Arthur Charles Woodward
 Harry Wormald
 William John Youden

Corporate Representatives

Wilfred Ashworth, *representing* The British Nylon Spinners Ltd.
 Peter Norman Blackaby, *representing* J. Lyons & Co., Ltd.
 George William Clarke, *representing* The Ministry of Supply
 Peter Lawrence Fidgeon, *representing* The Society of Motor Manufacturers
 and Traders Ltd.
 Harold E. Gorick, *representing* The Chamber of Shipping of the U.K.
 Barbara Adelene Holford, *representing* The Bowater Paper Corporation, Ltd.
 John Lappin, *representing* The British Electricity Authority (Southern Division)
 Daniel Strachan, *representing* Henry Simon (Holdings) Ltd.
 Thomas Douglas Victor Swinscow, *representing* "The British Medical Journal".

A DISCUSSION ON THE REPORTS OF THE ROYAL COMMISSION ON POPULATION

[Held before the ROYAL STATISTICAL SOCIETY on December 18th, 1950, The President,
Professor A. BRADFORD HILL, D.Sc., Ph.D., in the Chair]

Opened by Sir ALEXANDER CARR-SAUNDERS, Sir HUBERT HENDERSON, Sir GEORGE
MADDEX, K.B.E., and Professor D. V. GLASS

Sir ALEXANDER CARR-SAUNDERS:

When the Society did me the honour to invite me to participate in to-day's proceedings, I used the following words in the course of my reply: "No doubt it would be appropriate that the Society should consider the work of the Statistics Committee appointed to assist the Royal Commission on Population. It is true that I was chairman of this Committee, but it is also true that I was the least expert of all the members. My function (and it was not a light one) was to try and bring the experts to the expression of some common view." I went on to say that I would prefer to leave the exposition of statistical problems to others, but would be willing to open a discussion, in which case, to use my own wording again, "I should limit myself to the setting in which the Committee worked. This might not be altogether inappropriate as a preface to a technical discussion, because it is important to understand the limitations under which the Committee did its duties". This suggestion was accepted, and I will now attempt to carry out my undertaking.

Contemporaneously with the institution of the Royal Commission on Population three expert committees were set up, of which the Statistics Committee was one. The terms of reference of this Committee, as laid down by the Minister of Health, were "to formulate for the assistance of the Royal Commission on Population the statistical particulars necessary for the Commission's inquiry, and generally to advise the Commission on the statistical aspects of the inquiry". The setting up of expert committees to advise a Commission was an innovation. Commissions have always had access to expert advice; the novelty lay not in the fact that such advice was available, but in the constitution of specially constituted bodies with the duty of proffering it. It was commendable to recognize the need for expert advice, but experience shows that this method of making it available is not free from difficulty.

The duty of the Statistics Committee was not merely to formulate the statistical particulars, but also to advise on them. To advise means to interpret, and interpretation ranges from the elucidation of statistical terms to the discussion of influences bearing on events of which statistics are a measure. Thus, for example, it was within the province of the Committee to attempt to enumerate and assess the importance of the factors which have determined the movement of population in the past. But in so doing the Committee was entering a field where people who are not expert in statistics can well claim to exercise their own judgment. Hence arises the possibility, or indeed the likelihood, of trouble which did not emerge under the old system of obtaining expert advice through witnesses. An expert witness is not called upon "generally to advise," and his evidence is likely to be restricted, either by his own self-restraint or by the use made of him by the Commission, to points of which he has special knowledge. Above all, the expert witness has not been made such by ministerial authority; that is the important fact about this innovation—the setting up of a body of persons upon whom a duty is laid to proffer advice over a certain field. Such a committee has a public responsibility to discharge; it could do so by issuing a report containing its views on the problems within its field; but this might seriously embarrass the Commission if the views of the latter diverged in some important respects, as well they might, from those of the Committee; for the members of the Commission would be exposed to the reproach that they had disregarded the experts. Alternatively, if the Committee remained silent, it would be embarrassed if the Commission published conclusions which were not those of the Committee; for, unless otherwise informed, the public would infer that the views of the Commission were those of the Committee. If recent proceedings do not afford material for a case study of the difficulties, the explanation is not that the difficulties are imaginary, but that they were avoided by luck, cunning or compromise, or by a combination of all three. There is, in fact, an unsolved problem for students of government, namely, how to furnish commissions with expert advice.

After these general observations I may now pass on and describe the actual setting under which the Committee did its work. As was proper and inevitable, the Commission desired as a preface to its work to have the views of the Committee concerning the past history of population movements, the present situation, and probable future trends. The Committee furnished the Commission with a paper which was in part a guide to statistical terms, in part a summary of figures, and in part a very guarded commentary; emphasis was laid upon the need for more data and more analysis. The Committee early recognized that a special fertility census alone could provide some data deemed essential for any thorough analysis; the Commission concurred with this view, and as the result of a submission made by it a fertility census on a voluntary basis was authorized. The preparation for the census necessarily took time; it was conducted in January, 1946, under the auspices of the Commission, that is, nearly two years after the Committee was set in being. Tabulation of the data, also conducted under the Commission, was much delayed for various reasons; in fact such data from the census as are used in the Report of the Commission only became available very shortly before the Report went to the press.

From the beginning of its task the Commission planned to devote the first part of its report to an appreciation of the population situation and prospects; but while from time to time during the life of the Commission the Committee was able to make as a result of its investigations communications to the Commission which were helpful in elucidating matters of importance, it was not until early in 1949 that some of the material most needed by the Commission for the writing of the statistical chapters could be conveyed to it. Thus the Commission was obliged to go forward in the light of rather a dim lamp; families, it learnt, had certainly become much smaller, and the population could hardly be replacing itself. With this inadequate illumination it conducted its inquiry, and during much of 1948 was virtually in recess, waiting until the statistical chapters, which logically should have been written first, could be completed; meanwhile the Committee was busy; it held 62 full meetings, few of which lasted less than half a day, and some of which lasted all day; there were also numerous meetings of sub-committees. The Committee attacked many problems; some important sections of the statistical chapters incorporate some of the results. The Committee also explored many bypaths; it was, in fact, tending to act as a research organization, and ceased these activities in 1949 merely because it was then possible to analyse the first results of the census, to add these additional data to what had already been accumulated, and to provide the Commission, which was under pressure to report, with material sufficient for the early chapters.

I have outlined this story because reflection on it suggests certain observations. Leaving aside the difficulties already mentioned, which seem inherent in the institution of expert committees advisory to commissions, it is clear that much thought needs to be given to the use which can be made of them. Is an expert committee to investigate and research, or is it merely to advise on the basis of what is known already? This question could and should be decided before a committee is appointed. If investigation is thought necessary it must be borne in mind that research takes time, and that the investigation of one problem always brings other problems in view. Therefore sufficient time must be allowed, and it may be that the Committee should get to work well before the Commission takes up its task; further, the scope of the investigation needs to be defined beforehand, since otherwise the Committee may tend to function as a research organization to whose work there is no limit. To take the case of the Statistics Committee, it might have been advantageous if it had been set up before the Commission and charged with the duty of supervising a family census, analysing its results and combining them with other relevant knowledge as a basis for the Commission's work.

Since commissions are set up to make recommendations on problems regarded as having some degree of urgency, committees should only be asked to investigate when without further knowledge the commission could not do effective work. Experience shows that an expert committee can, if provided with funds, function with effect as a research organization; such a committee is, in fact, an *ad hoc* organization of the type to which the great councils in the medical, agricultural and scientific fields belong. But while research may or may not be a duty of an expert committee advisory to a commission, advice is always so. And I am not convinced that the best way of making expert advice available is to form experts into a committee. It is almost certain that each member would, if he acted independently, offer rather different, perhaps very different, advice. The advice of an expert committee is therefore likely either to take the form of a different

report from each member, in which case there is no gain in a committee, or of a compromise document in which each member suppresses the full implications of his view. If anyone were to say that this is equally true of a commission, I would reply that the two cases are not alike; the give and take between members of a commission, that is of persons of general experience who come fresh to a particular question, is quite unlike compromise between people who have given special, perhaps life study, to a problem. Thus, while commissions may well need to have expert *ad hoc* research organizations for their benefit, I am doubtful whether the new experiment of expert advisory committees will prove successful. I would prefer to see commissions hearing as many experts as they may wish to consult, and making the best of what they are told. In fact, I favour the old procedure in regard to expert advice; on the other hand, I favour much more extensive provision of special fact-finding organizations for the benefit of commissions than has been afforded in the past.

May I, in concluding these brief remarks, thank my colleagues, including the secretaries and research workers, of the Statistics Committee most warmly for their co-operation and their arduous labours. To my mind they were given a most difficult and harassing task. So far as there is truth in the observations I have made, their task was far more difficult than the public, even the instructed public, recognizes.

Sir HUBERT HENDERSON:

I shall not follow Sir Alexander Carr-Saunders in his critical comments on the rather peculiar structure of the Commission's inquiry, except to say that in considering the justice of such criticisms it is important to remember that the basic facts of the problem we were asked to examine were undergoing striking changes during the period when we were sitting. Something in the nature of what Sir Alexander called research on the part of the Statistics Committee and the staff of the Commission was clearly necessary because of that. The perspective of the problem by the time we came to prepare our report was, in appearance at any rate, very different from the perspective at the time we were appointed.

As Sir Alexander has not dealt with the statistical aspects of the report, I will rush in to say a word or two about them. It is about eighteen months since we reported, and most of our report was written on the basis of facts ascertained somewhat earlier than that. Eighteen months is a very short time in the eyes of demography, and a very short time by the standard of the period for which we thought it profitable to look ahead as a Commission and to make computations which, however carefully qualified, inevitably assume the character of contingent forecasts. Still, it is, I think, of some interest to consider the trend of vital statistics in the last year or eighteen months in order to find out what light they throw—obviously the light must be a fairly limited one—on the broad picture of the statistical prospect presented by the Commission, and what bearing they have on the scheme of statistical analysis which the Commission adopted.

Much controversy and criticism was naturally provoked by the method employed by the Commission for computing the probable course of births. That method was to treat the number of births as a function of two main factors—the rate of marriage and the average size of the family—and to examine these two factors separately rather than to rely on annual reproduction rate calculations, which had, it seemed to us, the defect of lumping together and confusing those two very different variables. We were impressed—nobody could have been otherwise who examined the facts—by the very large part which variations in the rate of marriage seemed to have played in the ups and downs of the birth rate during the last ten or fifteen years, and the comparatively small part played by changes in the average number of children born to recently married couples. In other words, in the terminology we employed there was no clear indication of any significant change in the average size of the family over the last two decades. The ups and downs in the number of births, the downward trend in the first two years of war, the marked recovery in the succeeding years, indeed, the apparently almost sensational recovery down to 1947, when the annual number of births went up to a million—and the subsequent setback—all these changes could be attributed wholly or almost wholly to variations in the rate of marriage in preceding years, and the consequent variations in the number of recently married couples. Though the number of recently married couples has undergone great variations, there did not appear to be any great change in the number of children born to them.

If that were true it had an important bearing on what was likely to happen in the near future. The marriage rate, which was so high during the war years and just afterwards, was more or less bound to decline, and this would, after a brief interval, result in a corresponding decline in the number of recently married couples—that is to say, in the number of couples married five or seven years earlier. As this decline became apparent, the number of births would fall too, unless the average size of the family began to increase decidedly, which has not occurred yet.

Our scheme of analysis, therefore, suggested that the annual number of births would be likely to fall considerably. Further, we suggested that the average size of family, which did not seem to have varied much in the last twenty years, was not quite enough to replace the population from one generation to another, given any rate of marriage consistent with stability in the average age of marriage. The average number of children born to married couples seemed not quite enough to replace the population from one generation to another.

This last was a point on which our critics in the statistical world especially concentrated, and I agree that it is open to fair dispute. It was suggested that our method of approach tended to discount unduly the significance of the huge rise in births in recent years. I suggest that what has happened since we reported serves, so far as it goes—and I do not suggest that it goes very far—to support our contention, and generally to confirm the reasonableness of our scheme of analysis and its helpfulness as a guide to future prospects. Quarter by quarter since we reported, i.e., during the latter half of 1949 and throughout 1950, the number of births has fallen back much as we would have expected on the assumption that the average size of the family—or, alternatively, the average number of children born to recently married couples—would not change materially. If anything the actual decline has been somewhat greater than might have been expected. I asked Mr. Hopkin, who is here to-night, to give me some figures on this point. I gather from him that whereas it would have been natural to expect on our assumption an aggregate of births for 1950 of just over 800,000, the actual number during 1950—the total is not yet complete—is likely to be about 785,000. The facts of the last two years or eighteen months do not therefore suggest that the high birth rates of the 'forties indicated any significant increase in the average size of the family. I hope Mr. Hopkin may be able to supply further chapter and verse. I refer to Mr. Hopkin for this reason. The Royal Commission as a whole were responsible for the statistical computations as well as everything else in the report. We are very happy indeed to bear that responsibility, and Sir Alexander Carr-Saunders's presence on the Committee shows that that responsibility was far from being a purely formal one. We owed much, too, to the suggestions and criticisms of the members of the Statistics Committee, but the fact remains that the main initiative and constructive ideas, as well as most of the sheer hard work of this part of our report, were supplied by Mr. Hopkin, and I am disposed to claim that he has made in this way what will be recognized as an outstanding contribution to demography.

May I say one word more upon this matter? The concept of the average size of the family has certain obvious defects, when regarded as a statistician's instrument. There is an inherent ambiguity which we acknowledged regarding the period of time to which it relates; and any attempt to define it more precisely raises various difficulties. How much importance, for example, should be assigned to the first three or four years of married life, compared with the next three or four? The attempt to judge how far the present size of the family is sufficient for replacement raises further difficulties, such as trying to judge what is a normal rate of marriage, which involves making certain rather arbitrary assumptions.

For reasons of that kind it is not easy—probably not possible—to use this approach of the concept of the average size of the family as a basis of an index comparable in its definiteness and precision to the net reproductive rate. But here I would suggest that it may be dangerous in dealing with so intrinsically uncontrollable a matter as the habits of human beings in marrying and producing children to choose one's statistical methods for the sake of their neatness and ease of application rather than for their correspondence to reality. A certain haziness of outline is in accord with the nature of the subject-matter.

I should like to make a brief reference to another matter. I am not altogether happy, on subsequent reflection, about that section of our report which deals with the change in the age composition of the population, and especially the prospective growth in the numbers of the elderly. I am disposed to think that the consequences of that change will in practice prove more important and the difficulties of handling it more serious than might be inferred from reading the report.

I do not mean that there is anything wrong in our statistical appraisement in the change of age composition, and we did not fail to call attention to various financial problems and problems of industrial organization which would arise. I do not think that there is any relevant consideration which we did not mention. It is a matter of emphasis, and even of shades of emphasis.

None the less, the prospect that the section of the population aged over 65 is likely to rise from about 10 per cent. now (or three years ago) to about 16 per cent. within a generation, while the number of young adults under forty is likely to decline, seems to me to justify graver disquiet than I think we suggested. The reasons for misgiving are greatly increased by two recent developments, namely, the establishment of the National Health Service and the clouding of the international outlook. The establishment of a Health Service which provides free medical treatment to every individual will mean a much bigger drain on our national resources than was originally supposed. With the ordinary healthy individual the need for medical attention increases in his declining years to a greater extent than at any other period, and if the number of the elderly are to increase in the way expected this tax on our resources may rise to formidable dimensions. On the second point the fact that we have to contemplate as part of the environment of our generation a condition in which defence expenditure will rule very high, and a large proportion of young adults will be absorbed in defence services, adds very greatly to the drawbacks of the decline that is to be expected in the number of these young adults. But that is the only section of our report where I plead guilty to some failure to present the problem in its true perspective.

SIR GEORGE MADDEX:

I will try to be brief, because it is obvious that in the remarks of Sir Alexander Carr-Saunders and Sir Hubert Henderson there is enough material to keep the discussion going for a long time; and though I should like to take up the issues which each of them raises I do not think that, as a member of the Statistics Committee, it would well become me.

I should like to say a few words on the circumstances which led up to the institution of the Royal Commission and the extraordinary change since then in the population position. Although the problem of the ageing of the population was implicit in various statistical reports in the 1920's—for example, the Government Actuary's report on the original Contributory Pensions Bill—the possible effects of the changes in issue rates in producing a declining population began to receive attention in the 1930's by the publication of reproduction rates, gross and net, and so forth. These rates showed a marked tendency to fall, and in the middle 'thirties there was a spate of computations of future numbers and age distributions of the population, which, as a result of the very large decline they showed a hundred years ahead, stimulated a good deal of attention in the popular press, where they were taken to be predictions, in spite of any qualification that a particular computer might have attached to his work.

Early in 1937 there was a debate in the House of Commons on a private member's motion drawing attention to the tendency of the population to decline and calling for an inquiry into the problem. Following on that, five years later, "in view of the interest in population problems"—as it was put in the preface to the memorandum—a memorandum was compiled by the Registrars General of England and Wales and of Scotland, and published as a Command Paper, on the current trend of population in Great Britain. Then, as a delayed reaction to all these stimuli, the Royal Commission was appointed in March, 1944, and presented its report five years later. In contrast to all that activity there now seems to be a great calm in the public press.

In reference to what Sir Alexander Carr-Saunders said, I think it should be borne in mind that the Statistics Committee was definitely an advisory body to the Royal Commission. It was not a group of demographic statisticians researching at large; its functions were strictly limited, and this limitation coloured all or most of its work. The surprising thing to me is that, owing to the initiative and ability of those assisting the Committee, the volume of genuine research—some, but not all, of which is incorporated in the large volume of papers of the Committee—is so much greater than anyone had a right to expect. That work must influence considerably and for a long time the lines of research likely to be followed on this subject.

The Statistics Committee spent a lot of time examining what was almost the *raison d'être* of the appointment of the Royal Commission, namely, the publication of reproduction rates—although by the time the Commission had got started there was a definite increase in the net

reproduction rate which rather cut away from the interest attaching to it in some quarters. The adjusted net reproduction rate for England and Wales had fallen from 0.84 in 1930 to a minimum of 0.75 in 1933, but it rose thereafter, with some slight setbacks, until in 1939 it was 0.81. During the war it rose again, and by 1946 it exceeded unity for the first time in a generation; in 1949, I think, it was 1.02 and so, for those who relied upon this index, the population problem seemed to be solved, with a margin!

It is a little surprising, in view of the researches done by the Statistics Committee and published in their papers, that the net reproduction rate, which (as stated in one of their reports) is a very mechanical index and may be misleading in use, should still be published with little or no qualification. The Registrar General for England and Wales publishes figures for an adjusted reproduction rate each year, and the new *Demographic Year Book of the United Nations* gives gross and net reproduction rates for a variety of countries. It is true that there is a qualifying note in the introduction to the latter publication pointing out that the recorded rates of mortality and fertility "do not actually represent the experience of any real generation of women and that they may be influenced by factors which are, of their nature, necessarily temporary"; but nothing is said about rates of marriage, for instance, and the importance of the reservation in practice and the limitations on the interpretation and comparability of the reproduction rates needs emphasis.

The difficulty is, of course, that if one ceased to publish reproduction rates of some sort a vacuum would be created, and nobody yet has found the right set of population functions to fill the vacuum. It is doubtful whether there is a single index of replacement which can satisfactorily be used; like the reproduction rate, if found it would be easily misunderstood and misinterpreted. Nevertheless, a simple indication of what is happening is desirable, for the examination of family census data of complete and incomplete families seems unlikely to provide a simple summary of fertility trends which can be readily appreciated by the layman. One of the demographic needs of the time is that somebody should be able to summarize in a simple form what I take to be the main elements—trend of marriage ages, extent of childlessness amongst married persons, spacing of families, and size of family.

Sir Hubert Henderson has already drawn attention to the point that the current high level of reproduction may well be due largely, and perhaps entirely, to the high level of marriages. The figures are indeed quite remarkable. Let us take the women of England and Wales in the age-group 20–24: in 1934, 27 per cent. of women in this age-group were married; in 1938, immediately before the war, 32 per cent. were married; and in 1947, 44 per cent. That alone is sufficient to maintain the fertility levels (fertility here meaning replacement) in spite of possibly very large declines in the basic fertility. Again, take the age group 25–29: whereas in 1934 the proportion of women married was 59 per cent., in 1938 it was 64 per cent., and in 1947, 73 per cent. To what extent these high levels are due to marginal marriages which might not have taken place but for the war, and to what extent they represent a permanently high level of marriage due to improved economic conditions, I suppose nobody knows; but they are perhaps more important than any other factor in contributing to the maintenance of the rate of replacement, or preventing it from falling seriously and giving rise once again to the qualms which led to the appointment of the Royal Commission.

I should like to say a word or two on the importance of more research—but very carefully planned research—on this subject. It seems to me that there are certain dangers, which may be exemplified by what happened to two official investigations. The 1911 census incorporated a special and ambitious investigation into fertility, but that was carried out on lines which were too grandiose; the results, published many years later, are in two large volumes which few but students ever consult. The 1921 census included a dependency investigation—quite a different objective—which seemed at the time more manageable and of more immediate practical utility; but, unfortunately, the replies on the census schedule were so unsatisfactory as largely to vitiate the results. Apart from this difficulty, the rapid changes in family size due to war and post-war factors preceding 1921 would have made the returns a dubious guide in estimates for the future.

At the present time the investigation of the dependency aspect is as important and pressing as the fertility aspect in these investigations. Valuable work could now be done in analysing the structure of the population in domestic units, the make-up of groups living together, allowing for relationships, degree of dependency, etc. To what extent the census of 1951 may give consideration to these groupings I cannot say, but there is an urgent need of information here, and

it is one that can be satisfactorily met only by large-scale investigation. The information resulting from investigations of that kind might be particularly helpful in tackling the statistical aspects of one of the matters on which Sir Hubert has touched, namely, the problems presented by the ageing of the population, which are likely to become formidable during the next twenty or thirty years.

Professor D. V. GLASS:

It may be useful to deal with three main heads here: the methods of analysing fertility; the collection of data relevant to the study of fertility; and the provisions for the continued analysis of such data. Practically all I have to say is at least implicit in the papers of the Statistics Committee, but since that is a large document it may be helpful to recapitulate a number of main points here.

As regards the first head, anyone studying the reports and selected papers of the Statistics Committee will find that, at various stages of the Committee's work, a large number of approaches were used—including the customary forms of reproduction rate, varieties standardized for marriage, joint maternal and paternal rates, and rates based on duration-specific marital fertility instead of age-specific fertility. In addition to reproduction rates as such, much use was made of the analysis of changes in the duration-specific fertility of individual marriage cohorts, both as a powerful means of investigating the trend of fertility within marriage, and as a basic stage in constructing new estimates of the level of reproductivity.

It will be seen from the report of the Statistics Committee that members of the Committee were not unanimous as to the most useful methods of analysis. There was, however, general agreement on one important point—namely that there is no short-cut method of analysing fertility, and no simple and single approach which is superior to all others.

The study of fertility in western countries, in which family planning is widely practised, is a very speculative enterprise, and one in which the analysis of events of a short period may easily lead to a false interpretation of what is happening in the present, and hence give an equally false indication of what is likely to happen in the future. The more ready people are to control the number and spacing of the children they have, the more complex is the task of analysing fertility in a meaningful way, from the point of view of both short-term and long-term trends. At the same time it becomes increasingly important to study the spread and effectiveness of family planning practice, and the factors (both external and psychological) affecting the way in which such practices are applied. The inquiry directed by Lewis-Fanning made a beginning there, but it was only a beginning, and much more of this kind of work needs to be done in the future.

It is also clear that, in general, there needs to be a much closer link between the statistician and the sociologist in demographic investigation than has been general in the past. This applies to the study of fertility as a whole, to the specific study of social class or equivalent differences in fertility, and to marriage frequency and marriage habits. It is not just a question of handing to the sociologist the task of studying fertility in its social context. It is equally important that the sociologist should help to frame concepts and definitions which may result in more meaningful indices of fertility, and in suggesting characteristics which may usefully be specified in collecting official and other data on fertility problems.

As regards the second head, the reports of the Statistics Committee also make clear that, even with regard only to data collected by Government, a very wide range of information is necessary if there is to be an adequate study of fertility. The Population (Statistics) Act has certainly provided for such a wide range, and our present vital statistics are, so far as fertility is concerned, among the best in the world. There are, however, still certain requirements: the analysis of material relating to social class differences in marriage, which would involve the improvement (at least in England and Wales) of the basic data collected on marriage registration, and the matching of such data with census returns; some alterations in the form of questions and of tabulations of questions to provide for a more consistent analysis of fertility statistics from registration material; and the provision of a wider range of accurate information relating to divorce, migration and death, in order to improve the reliability of the basic population estimates without which the Population (Statistics) Act data cannot be utilized to full effect.

It is, of course, evident that the more complex the range of questions asked on birth registration,

the more difficult the task of providing for adequate estimates of the relevant basic populations. It is certain, for example, that in order to have reliable estimates of the populations of women by age, marital condition, marriage duration and numbers of previous births, frequent fertility censuses are indispensable. Such censuses, of course, also have an independent value in the study of trends, and they are necessary to provide for inquiry into social class or equivalent differences in fertility which cannot be measured very satisfactorily from vital statistics alone. From that point of view, too, fertility censuses need to be frequent. With infrequent fertility censuses one inevitably has to make use of the data relating to the older marriage cohorts, and to use these cohorts introduces a powerful degree of self-selection which may not be unconnected with fertility.

But much more experimental work is necessary in connection with the planning of future fertility censuses, experimental work which may perhaps be carried out on smaller sample bases either by governmental or by private organizations. So far, for example, social status allocation has been based only on the occupation of the husband at the time of interview. The 1951 census will also contain information on education which may make for much more significant results within the framework of occupational status. There is also need to consider other factors of relevance here—for example, taking occupation alone, should the question be confined to occupation at date of interview? What differences in fertility trends would appear if occupation at time of marriage were asked, or occupation at the birth of each child? Is it in fact desirable to obtain a whole occupational or social mobility profile for the marriages covered in a fertility census? There are also the practical problems of tabulation which need to be examined at greater length, particularly if the date of birth of each child is to be asked again in future. The method which had to be adopted when the Family Census was taken meant that the really laborious work began when the tabulation sheets became available. In order to simplify this work it may be necessary to sacrifice some elements of accuracy, and to tabulate results entirely in terms of calendar years of marriage and calendar years of birth, rather than in terms of exact duration.

Because of the wide range of information required for fertility analysis, and because, too, of the inevitable difficulties involved in attempting to match census and registration results, the Statistics Committee drew up proposals for a system of continuously inter-linked vital registration as a means of studying fertility. The object would be to have a card for each marriage, and to have entered on that card all the relevant data concerning the partners and the issue of that marriage. Such a system does exist in the Netherlands, which has continuous registration, with a family card created as soon as a marriage occurs (in addition to an individual card for each person in the country). Clearly, if the system of marriage cards could be initiated and maintained at the desirable level of accuracy there would be very great advantages for many aspects of demographic analysis. The question of practicability is, however, of very great importance, and the Committee accepted the view of the General Register Office that, at least at present, the proposal would not really be workable. It should not, however, be taken that this will always be the case, and one of the points put forward by the General Register Office is not, in my view, valid in principle. The General Register Office Memorandum said that the proposed system would give "a variable and uncertain cross-section adulterated by the inclusion of many families which had left the country and imperfect as regards the families included, by reason of failures of linkage." But if the linkages were successful, and if the families of persons who had died or who had left the country could be identified as such, there would be very good reason indeed to have them in the system for the sake of the information they would give on important but so far neglected segments of the population.

As regards the third head, provisions for the continued analysis of fertility data, the Statistics Committee had in mind the expansion of the technical staff of the General Register Offices in this country. The Committee was strongly of the opinion that no proposal should be accepted which involved divorcing from the General Register Offices the analysis of the fertility data for the collection of which they are responsible. There are clearly good reasons for this point of view. In particular, those who are responsible for collecting the data should be best able to realize the limitations of their data. But the Committee was also very much concerned with the fact that the analysis of fertility on the lines which it had suggested would involve a very much larger expenditure of effort than the General Register Office had hitherto been able to give to this subject. It is of course important to emphasize how much pioneer work the General Register Office has undertaken on this, as on other aspects of the field of demography. These efforts

have usually been made under severe handicaps, for the General Register Office has traditionally been treated as the orphan child of Government departments. Certainly the Statistics Committee was convinced that the new lines of analysis appropriate in studying fertility trends and patterns would involve not only a very great increase in routine labour, but continuous experimentation of high technical quality. The study of fertility has by no means reached the stage at which it can be said that the important lines of analysis are known and generally accepted. It is thus all the more desirable that the work of experimentation should find an essential place in the General Register Office, alongside the collection and the more routine analysis of the data concerned.

To end on a personal note, I am very glad that Sir Hubert Henderson has mentioned the work of Mr. Hopkin. But I should also like to draw attention to that of Mr. J. Hajnal, who was research worker to the Commission. I am sure the other members of the Statistics Committee will agree that the work of Mr. Hopkin and Mr. Hajnal has made an outstanding contribution to demography.

Mr. R. C. K. ENSOR said that as a member of the Royal Commission he had listened with very great interest to the discussion so far as it had proceeded, and was in very large agreement with what had been said. He was particularly glad to hear the tributes paid to Mr. Hopkin and others, to whom the Commission was indebted for much assistance. It was quite probable, as Sir Hubert Henderson had said, that calculation of the average size of family in preference to calculating the net reproduction rate had definitely come to stay. Its advantages over the old method were quite clear. But it should be realized that those advantages could not be obtained save by censuses which provide the raw material. They would have done very little on the Royal Commission if they had not had that sample census, and great credit was due to the Treasury for permitting it to be taken. The cost to the country was quite considerable, but it was well worth doing, and ought to be done again at regular intervals.

In the 1911 census special data were obtained throwing a very valuable light on many aspects of population; but in the following censuses nothing was done. When the suggestion was raised in Parliament, members broke into outcries about "snooping" and that sort of thing, which prevented further exploration. The Royal Commission's census was on a voluntary basis, which was not entirely satisfactory. There should be regular censuses from time to time, yielding the data that were absolutely indispensable. Not only were censuses needed from time to time, but at all times Governments in framing their policies should have regard to the population trends and variants as affected by the questions before them. They had never done that in the past. Broadly speaking, the policies of this country had been shaped without any attention to population aspects. That would go on, and could not help going on until there was an efficient organization for dealing with that aspect of each problem.

The recommendations of the Commission fell broadly into three sections. They recommended certain expenditures of money on grants of family allowances and on income tax reform. They recommended also a large number of social service developments. But then they recommended further that there should be set up a machine which would on the one hand stimulate and conduct research in population questions, and on the other hand bring the bearing of population questions to the attention of different departments and Ministries concerned in the framing of national policy. Their recommendations under this third head, unlike the others, cost almost nothing; and it was very important that they or something like them should be carried out. They were extremely modest. They scarcely proposed any new machinery, but only the adaptation of existing Government machinery. They proposed that a Minister, the Lord President of the Council, should be made the Minister responsible for population questions, under whom the existing Committee for Social and Economic Research should constitute a subcommittee to deal with population questions, and should broadly speaking discharge the duties indicated. Eighteen months had gone by, and he had not heard that anything has been done in that direction.

He would suggest to the Society as a learned and important body that this proposal should not be ignored, and that any influence that can be brought to bear to induce the Government to act in that direction should be employed.

Mr. GREBENIK said that as reference had been made to the Family Census he might add a little about that piece of work. The 1911 fertility census took a long time to publish, and as an equally long period seemed to elapse between the taking of the 1946 Census and its publication, he desired to say a little about the difficulties. In the first place they were advised that as the law stood at present no compulsory sample census could be taken in this country; any investigation on a sample basis had to be voluntary. Unfortunately, the Census encountered a good deal of

hostility in the Press, and this unfavourable publicity was in many cases effective. The Celtic fringe seemed to have been less affected by unfavourable Press comment; in Scotland and Wales and also in the North of England people were willing to reply. But in London and in the other bigger towns of the country there was a higher refusal rate, and also, as the population was more mobile, there was more difficulty in making contact. In order that the rates which would ultimately be calculated should be correct it was necessary to adjust the data locality by locality, and this was a long and time-consuming process.

Special mention should be made of the willing co-operation by various government departments, who quickly responded to requests for help. Assistance was received at various stages of the inquiry from the Treasury, the Ministries of Food, Labour and Supply, the General Post Office, the Board of Inland Revenue, the National Assistance Board, and the Department of Customs and Excise. His Majesty's Stationery Office responded to varied requests for all kinds of services with promptness and dispatch. Without the help of these departments, quickly and readily given, enumeration would not have been possible.

Other difficulties were encountered in the tabulation of the data, partly because the tabulations were new and experimental, and partly because the Census was taken at a time when the economy was in a transition period between war and peace, when labour and machine capacity were difficult to get. They were forced to carry out tabulation in many centres scattered around the whole country, with all the difficulties of co-ordination that that involved. He did not think that such conditions would obtain in future family censuses, and there seemed no reason why with the experience gained in this Census results should not appear within a reasonable time.

Commenting on some of the results, he said that under present conditions something like 80 per cent. of the total fertility of married couples seemed to be achieved within the first ten years of marriage, and it should not be difficult to make inferences about the total fertility of marriages for couples who married as recently as ten years ago. This might meet the point of one of the previous speakers, who said that the method would only yield results which were already out of date.

Another point which surprised him considerably was the stability in the gap between the fertility of the two main social classes, the manual workers and the others. He had expected that differences in family size would have decreased considerably, but this did not seem to be the case. The fertility of manual workers remained at a level about 40 per cent. higher than that of the non-manual group, and the size of the gap did not appear to change. They were investigating what happened when the population was divided into rather more social groups. They were also looking at the influence of age at marriage on total fertility—an important point, particularly in a population in which there was widespread practice of birth control, and they were investigating whether the differential persisted when age at marriage was held constant.

Mr. W. A. B. HOPKIN said that most of the statistical analyses of the Royal Commission report, published in the middle of 1949, were based on data terminating in 1948, a year still within the post-war wave of high birth-rates, and the Commission had to take a view of what could be regarded as the normal level of fertility. We were now getting some way away from the end of the war, and it was not unreasonable to say that any judgment as to what was a normal post-war level of fertility should accord reasonably well with what had been happening in 1950. Sir Hubert had given them figures which showed that the births for 1950 came out quite near to what the Commission had expected. Actually they came out a little lower, and it might be interesting to the Society to have them in terms of an index of reproductivity.

The Royal Commission gave an index of reproductivity which in terms of current mortality worked out at about 90 per cent. The Commission used the figure 94 per cent., making an allowance for future decline in mortality. In terms of current mortality it came out at 90 per cent., and was so given in the Commission's report. The figure for 1950 came out at 88 per cent.—just a little lower, but in the same region as the Commission's estimate. Both these figures took account of the abnormally high proportion of recently-married couples in the population, and this was the reason why the level of reproductivity was only slightly higher than pre-war, in spite of the higher number of births. The number of legitimate births in 1950 would be about 12 per cent. higher than in the four years before the outbreak of war, but 11 per cent. of this was accounted for by the larger number of married couples.

One interesting consequence of this experience was the light which it threw on certain arguments regarding age at marriage. It had been argued that the Royal Commission had paid too little attention to the effect of younger marriage on the size of the family. It was a well-known fact that in all generations those who married younger had on the whole larger families than the average. The inference was drawn from this that when people came to marry younger they would have

larger families, and that it would be wrong not to make a large allowance for the effect of the age of marriage on fertility.

The fact that the births in 1950 were reasonably near the expectation deduced from the Royal Commission's judgment on fertility levels did suggest that the average size of the family was not rising substantially owing to the fact that people were marrying younger. In his view this cast some doubt on the importance of doing the statistical analysis in terms of age of marriage. On the view he was disputing it would be necessary to suppose that the comparison between 1950 and 1935-38 showed the result of two almost exactly balanced forces, the effect of younger marriage tending to raise family size, and the effect of some mysterious decline of fertility cancelling this out.

Sir Hubert Henderson had remarked on the ambiguity of the expression "the present size of the family". The difficulty about the exposition as set out in the Royal Commission report was that it was not possible to point to any one particular group of people and say that by the "present" size of family one meant the average size of these people's families. He did not think there was anything wrong with the basic ideas, but it led to clear thinking if the problem could be stated in terms which were not ambiguous. The way to do this was to start from the actual reproductive achievement of a particular generation. This had never been worked out in this country, but it could be done, particularly when there were available the data from fertility censuses. One traced the reproductive history of all the people who were born in a particular period, say 1895-1900, the object of the calculation being to discover the ratio of the children born to that generation to the numbers in the original group.

He thought the way to look at the problem was this: supposing that this statistical exercise had been done, and one had worked out the data for all the generations up to and including those who had just completed their passage through the reproductive period. Then it was desired to know what would be the ultimate replacement rate of the people who were now passing through that age. There were data of varying completeness for the people who were at different ages within that group. At the older ages of the group the calculation could be fairly accurate; at age 35 it was still not very dubious; at 30 it became more dubious, and so on. But it would be possible to make a shot at the estimate, the shot, of course, being more precise the older the group with which one was dealing, and becoming less precise as one came down towards the twenties. What they were seeking was a method which would not be open to the charge of ambiguity at any point. One could say, "Here are data for the people now aged 35 and over. It looks as though the ultimate replacement rate would be 90 per cent"—or whatever it might be.

He expressed the hope that either in official or in unofficial circles some such approach as this would be adopted.

Mr. E. H. STERN wished to offer some criticism of the treatment of the so-called "burden" of the age-groups over 65. A burden was a concept of relativity, and could only be measured against the capacity to bear it. There was a lot of gloomy talk about the increase in numbers, but hardly anything was said about the increase of income per head of the working population. If the ratio of those over 65 were to rise from 5 to 10 per cent. within 30 years and the incomes per head rose by $2\frac{1}{2}$ per cent. at compound interest, the "burden" would not rise at all; on the contrary the under 65's would still be better off. Secondly, the rise of real income at some rate was not unconnected with the increase and improvement of industrial equipment or with better education and health, and the consequent increase in the expectation of life and the length of working age. Much of this was due to the savings and the scientific and business enterprise of those who in thirty years would be over 65. Thirdly, the budgetary "burden" of assistance to the over 65's was to a large extent a consequence of the inflationary policy of our era. Inflationary policy, whatever its justification, was prejudicial to the over 65's, whom it robbed of their savings for the benefit of those still at work. The over 65's could not adjust themselves to the consequences of inflation as easily as those under 65. Increased money expenditure for the over 65's falling on the budget only restored partly what was taken away from the over 65's by inflationary finance. To sum up, the problem of the "burden" of the over 65's was exaggerated and wrongly focused.

As a result of the ballot taken during the meeting the candidates named below were elected Fellows of the Society:

Evelyn Martin Lansdowne Beale.
 Gordon Clement Billington.
 Ronald Massey Blunden.
 Norman Leslie D'Abbs.

Ravibhushan Anant Datar.
 Frederick Hamlyn Dennis.
 Freda Fairclough.
 John Robert Green.a

Alan Albert Grove.
 Walter Frank Harris.
 William Charles Henshaw.
 Mahmoud Ibrahim.
 William Neil Jessop.
 Alexander Eric Keddie.
 John Parry Lewis.
 William Andrew Brown Milligan.
 Frederick Moore.
 Jean-Pierre Mothes.

James Porteous.
 George Woodrow Roberts.
 Salib Roufael.
 M. R. Siddiqi.
 Mary Elizabeth Solari.
 Wallis Taylor.
 Rupert Sydney Timberlake.
 Rolfe Cartwright Tomlinson.
 Asher Tropp.
 Kenneth Edward Walker.

Corporate Representatives

Douglas Arthur Brown, *representing* Attwood Statistics, Ltd.
 George Vernon Kennedy Burton, *representing* Fisons, Ltd.
 Graham Hopper, *representing* The Mond Nickel Co., Ltd.

EARNINGS AND CONDITIONS OF EMPLOYMENT IN AGRICULTURE

By H. PALCA and I. G. R. DAVIES

Introduction

During the last five years the Ministry of Agriculture and Fisheries, of which Department we are technical officers, has obtained information about the earnings and conditions of employment of farm workers in England and Wales by means of a random sample of farm visits undertaken in connection with the enforcement of the Agricultural Wages Act, 1948.* This article is to describe some of the principal features of the investigation, especially of the sampling techniques employed, and to make known the more important results. They have not been published hitherto.

In the agricultural industry there is a statutory determination of minimum rates of wages related to a standard working week, and overtime rates and certain other elements of farm workers' remuneration are also statutorily determined. Until the inquiry we now describe had been under way for some years, however, there was no firm information on average weekly earnings. These are made up of minimum wages, premiums, overtime and piecework earnings, "allowable" and "non-allowable" perquisites, and bonuses, but are reduced to the extent of time lost by sickness or holidays, if not paid for, and to the extent that certain workers receive less than the ordinary minimum wages by reason of partial incapacity.

The inquiry is undertaken on approximately 5,000 farms per annum. The number of farms (or holdings) in England and Wales on which labour is employed in the summer is about 200,000. The total number of holdings is 375,000, but 120,000 of these would not ordinarily be considered as farms. Some 50,000 true farms, therefore, employ no labour. (Strictly speaking, they return no labour at the annual censuses. The occupier is instructed not to return himself, his wife, or his children enrolled at school; he should, however, return any working partner on the holding, and any part-time retired person assisting on the farm, but may not always do so.)

From the figures given it will be seen that the sampling ratio is about $2\frac{1}{2}$ per cent. Reasons will be given for believing that this low ratio is not inconsistent with highly accurate results for the principal information desired.

The inquiry should be almost free from observational error. The inspections are made by trained staff of the Ministry, who have statutory powers of access to the farms, and whose visits are made for wage enforcement purposes. The Wages Inspector interviews the employer and employees, and inspects any wage records available. It is unusual, except where any contravention of the Act is found, to discover any conflict between the statements of the employers and employees, and in any case it is the Inspector's duty to satisfy himself as to the true facts. The Inspector enters these on forms which are uniform from farm to farm.

The inquiry does not include any farms which the Inspector may have visited as the result of a complaint, but is based solely on test inspections according to a random sample. It does, however, exclude workers not working under a contract of service within the meaning of the Agricultural Wages Act. These will be mainly relatives of the farmers† and salaried employees. In addition the inquiry does not cover workers on the farm who are not employed by the farmer, such as members of contractors' gangs, and workers belonging to the pool labour service operated by the County Agricultural Executive Committees. The inquiry does include the partially incapacitated persons referred to earlier.

The Sample

The sampling system used may be briefly described as "stratified random sampling, with varying sampling fractions"; the strata subject to the different fractions being strata of size-groups of farms

* A similar inquiry is conducted in Scotland.

† Of the total of 741,000 workers returned in 1948, 110,000 were family workers, and of these only 20,000 were considered to be working under a contract of service.

where size is defined in terms of numbers employed in June. This system had previously been tried out on agricultural data in the compilation of the statistical results of the National Farm Survey (1941/3), and the methods then used were in turn derived from recent work by Dr. F. Yates and his colleagues at Rothamsted. The application of this system of sampling to agricultural data has been commended for general adoption by the Statistical Commission of the United Nations; it is treated in some detail by Dr. Yates (1949).

The advantages of randomness and stratification will be generally appreciated. One good reason for stratification in this case is the observed tendency for absolute earnings per worker to vary with size of farm, being perceptibly greater as a general rule on the larger farms. The varying sampling fractions may need further explanation. In this instance the larger farms, defined in terms of numbers of workers, carry the highest fractions. (The range of fractions, described in more detail below, is from 2.1 per cent. for the smallest size to 10.7 per cent. for the largest; the average, as stated, is $2\frac{1}{2}$ per cent.) It will be seen therefore that a result of the varying sampling fractions in this case is that the sample contains a large number of workers in relation to the number of farms visited, which is an important point when the cost of the inquiry tends to vary much more with the number of visits than with the number of employees inquired about. If one can think of a ratio of accuracy to Inspector's time, this method is designed to maximize it, by exploiting the principles (i) that the sampling error of the factor being measured (in this case principally average earnings per head) diminishes (all other things equal) as the number of observations increases, and (ii) that sampling error in the inquiry as a whole can be diminished by devising a pattern of sub-samples such that the sampling fractions are proportional to the within-strata standard deviations of the units. In addition there is a practical reason for varying sampling fractions in this particular inquiry. It is desired to obtain information about different occupational classes of farmworkers; the more specialized classes are found chiefly on the larger farms, where diversity of employment is possible; and a uniform sampling fraction over the whole field would produce too small absolute numbers of these specialists for an accurate estimate of their earnings.

Within this general framework the size and composition of the sample have varied slightly each year since the inception of the inquiry. In the year 1949 it consisted of 4,896 farms. That is to say, this number of farms was selected at random. The number actually visited was 4,747. The difference consisted of a small number of farms which could not be visited for practical administrative reasons (to this extent randomness was vitiated), and of a rather larger number which had disappeared since the sample was drawn for some such reason as amalgamation with another farm. Of the farms visited, 39 were rejected from the inquiry because at the date of the visit there were no employees, or the employees were of classes not covered by the inquiry.* There were no casualties on account of failure to give information, or the giving of inadequate information.

Method of Selection

The sample for each year is selected from one of the most recent June 4th Agricultural Census returns as follows:

(a) A Hollerith card bearing the county/parish/holding number and details of the labour returned at June is prepared for each holding in England and Wales. The list of all holdings in the country is believed to be virtually complete.

(b) All cards are sorted into size-groups, according to the number of certain types of workers employed. For the first sample (September, 1945, to October, 1946) the classification was based on the number of all workers employed. It was discovered, however, that this number does not necessarily bear any constant relationship to the number employed at other times of the year, so that a holding classified to one group on the basis of June numbers often fell into some other group when inspected. In order to avoid this unnecessary shift of holdings from one group to another the classification for succeeding samples was based on the number of regular men employed per holding, since the number of such workers remains relatively stable.

(c) All cards are then arranged in order of their county/parish/holding numbers within each size-group, and the required number of holdings selected by extracting the cards at fixed and regular

* There were many other farms on which some of the workers were found to be not employed by the farmer, or were not working under a contract of service, but the farms were retained in the inquiry in respect of the remaining workers.

intervals (e.g., the 3rd, 6th, 9th cards, etc.). This introduces stratification by counties and parishes within the major strata of size-groups, and ensures proportionate representation (within a size-group) of holdings in all areas in the country. Since there is no connection between the type of farm and its identification number, the method also ensures proportionate representation (within a size-group) of holdings of all farming types.

(d) The most recent samples (from January, 1948, to December, 1950) were selected from the June returns for 1946, but the samples for 1951 and 1952 are being drawn from the June, 1948, lists.

Details of the size-groups and sampling fractions used for selecting the sample for 1948 are given below.

TABLE 1.

Group Number	Description of Groups	Number of Holdings		Sampling Fraction Per cent.
		England and Wales, June, 1946	1948 Sample as drawn	
1	No regular workers or W.L.A. but 1 or more other workers*	25,800	—	—
2	No regular males 21 and over but 1 or more regular workers or W.L.A.	32,927	690	2.1
3	1 regular male 21 and over	67,164	1,502	2.2
4	2-4 regular males „	56,082	1,870	3.3
5	5-9 „ „ „	13,249	632	4.8
6	10-14 „ „ „	2,993	198	6.6
7	15-19 „ „ „	1,018	84	8.3
8	20+ „ „ „	1,206	129	10.7
Total of Groups 1 to 8		200,439	5,105	

* Not sampled.

For practical reasons holdings employing only casual workers at June are not represented in the sample. One reason is that it is very difficult to obtain reliable information about the earnings of individual casual workers because much casual work is done by gangs on a contract basis, at rates which are frequently inclusive of the charge for any machinery used. Secondly, many of the holdings employing casual labour at June employ no hired labour at other times of the year, so that the inspection of such holdings might result in fruitless visits and a waste of the enumerator's time.

When the holdings embraced in the sample have been selected, they are apportioned among the 25 Wages Inspectors, each of whom covers a district. Up to the end of 1949 the holdings were notified to Inspectors on an annual basis, but are now allocated as from equal sub-samples, one to each quarter. Within the quarter the Inspector is free to visit the holdings in any order, and will usually choose his order to minimize travelling time. Every effort is made to spread the inspections in each district as evenly as possible within each quarter so as to take full account of inter-farm and inter-regional seasonal variations.

The data collected at each inspection relate to the four weeks immediately prior to it. Details are collected of each worker's main occupation, relationship to the employer, earnings received, components of those earnings and hours worked.

In the 1949 inquiry information was collected for workers on 4,708 farms. On these farms there were found to be 20,658 regular workers and 2,539 casual (or part-time) workers. The corresponding numbers of workers for whom full data were obtained were 17,380 and 1,798.*

From these figures it can be calculated that the average number of workers per farm inspected

* The remaining workers were rejected as not being employed by the farmer or not under a contract of service.

was five. This is greatly in excess of the true average for the country. The excess is, however, a feature merely of varying sampling fractions as applied in this inquiry; and being deliberate and measurable, can be corrected quite simply when national totals and averages are produced.

General Description of the Chief Results, and Sampling Errors

(a) *Numbers of workers, by occupation.*—The main occupation of each worker is recorded by the Inspector, and an estimate of the total number of workers in England and Wales in each of the main occupational groups is obtained by applying the percentage distribution for the holdings inspected in each size-group to the total number of workers in those size-groups in the country. Complete purity of classification is unattainable, since nearly every worker performs a variety of tasks, and the importance of each task relative to the whole often varies from season to season, and even from day to day. The classification of any worker to an occupational group is therefore a matter for individual assessment, and may on occasions be rather arbitrary in character. No group may therefore be regarded as homogeneous, but it can be claimed that the group described as, say, cowmen will consist of workers who over the year are predominantly engaged upon tasks connected with cattle and assume the normal responsibilities associated with that class of work. The results for the first four years exhibit a strong degree of continuity within occupational groups, which suggests that the method of estimation is reasonably satisfactory.

Other data collected make possible subsidiary estimates of the number of employers' relatives working on farms, the number of workers receiving board and lodging or cottages, and of other items of like interest.

(b) *Earnings and hours of work.*—From the Inspectors' returns the average earnings, etc., per week for the four weeks prior to inspection are calculated. The data are then summarized on a quarterly basis for each occupational class within each size-group. The average earnings (and their individual components) of all workers in each "main occupation" are obtained by weighting the "size-group averages" by the estimated number of workers in these groups in the country.

The scope of the inquiry extends, however, beyond the determination of the earnings and the hours worked per week. Thus detailed information is obtained about the composition of earnings in terms of cash wages, board and lodging, cottages, perquisites, bonuses, overtime and piecework cash earnings, etc., and about the distribution of the hours worked over ordinary time and overtime—the latter being partly at weekday and partly at week-end rates.

(c) *Sampling errors.*—Each item of information in the inquiry has its own sampling error, but the only items which have been systematically examined in this respect are average weekly earnings of the principal occupational groups of adult males.

The determination of sampling error depends on strict randomness, and here it has to be admitted that not all the farms originally selected at random produced valid returns, though in the overwhelming majority of cases there is a good reason, such as that the farms are found upon inspection to have gone out of existence, or the workers to be not within the ambit of the inquiry.* It does not appear, however, that, except for those few farms which were not visited by the Inspectors only for lack of time, the essential principle of randomness has been vitiated, if this may be taken as requiring that all farms producing valid returns had no greater or lesser chance of being included in the inquiry than others that could have produced them, but were not selected.

Even on the footing, however, that complete randomness in the strictest sense was not obtained, any consequential tendency to under-estimate the experimental error may be said in general terms to have been offset by over-estimation of the sampling errors. To obtain the variance of mean earnings per worker in a group, the variance of earnings has been divided by the number of farms. This approximation renders probable an over-estimation of the sampling error, the difference depending upon the relative magnitudes of the inter- and within-farm variances, and between the number of workers per farm and the number of farms in a group. Further work on this subject is proceeding.

* In most cases, however, absence of contract of service with the farmer led to a diminution in the number of workers rather than the number of farms reported upon, i.e., most of the farms upon which some workers had no contracts of service also employed other workers who had, and farms employing labour on contract also employed direct labour.

TABLE 2.—*Wages and Employment Inquiry (England and Wales): Averages of Actual Weekly Earnings of Regular Hired Agricultural Workers*

	(October–September years)								Change 1945–6 to 1948–49		
	1945–6		1946–7		1947–8		1948–9		Amount		Increase % (†)
	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	
<i>Statutory Minimum Wage per week—</i>											
Men	72	2	80	10	90	0	92	2½	20	0½	28
Youths, 18 years old	52	6	58	7	65	0	66	8½	14	2½	27
Females, 21 years and over	50	10	60	4½	68	0	69	8	18	10	37
„ 18 years old	49	11½	56	3½	63	0	64	8	14	8½	29
<i>Average Total Earnings per week—</i>											
<i>Men (21 and over)—</i>											
Bailiffs and foremen	106	5	113	11	123	4½	126	6	20	1	19
Cowmen	99	3	109	1	121	9	126	7½	27	4½	27
Other stockmen	93	9	100	10	112	3½	116	0	22	3	24
Horsemen	92	5½	100	3	109	6	115	3	22	9½	25
Tractor drivers	91	0½	99	4½	106	6	110	8½	19	8	22
Lorry drivers	100	7	109	10	121	0½	123	6	22	11	23
General workers	83	6	91	8½	101	11	104	8½	21	2	25
Market gardeners	90	11	90	6	100	6½	104	0½	13	1½	15
Ancillary workers	93	2½	99	9	108	9	111	6½	18	4	20
<i>All Hired Men</i>	88	9	96	6	106	4½	109	10	21	1	24
<i>Youths (under 21)—*</i>											
General	50	0	58	1	65	10½	70	5½	20	5½	41
Other	58	9	64	6	73	8	75	0	16	3	28
<i>All Hired Youths</i>	51	11	59	6	67	5½	71	4	19	5	37
<i>Females (incl. regular W.L.A.†):</i>											
<i>(a) Women—</i>											
General	57	8½	66	5	74	5½	78	4	20	7½	36
Other	60	6½	68	9	77	1	80	1	19	6½	32
<i>All Hired Women</i>	58	8	67	3½	75	9	79	4	20	8	35
<i>(b) Girls—*</i>											
General	43	2	48	11½	63	2½	61	7½	18	5½	43
Other	42	6	45	9½	60	8	63	3	20	9	49
<i>All Hired Girls</i>	42	10½	47	0½	62	4	62	9½	19	11	46
<i>All Hired Females</i>	56	11	65	0	72	6½	74	4½	17	5½	31

* The figures for youths and girls are influenced by the average ages of the youths and girls in the sample. These ages are not quite the same in the sample and the "population" and varied from year to year during the inquiry. The preparation of a "corrected" index has been undertaken as a separate study.

† From October, 1945, to December, 1947, "Women" include all females of 18 years or over. From January, 1948, "Women" include all females of 21 years or over.

‡ To the nearest 1 per cent.

Even with this proviso, the sampling errors turn out to be remarkably small.

Category of Worker (Adult Male)	<i>S.E. of Mean Earnings per Week as Percentage of Mean Earnings per week, 1948-9.</i>
	Per cent.
Bailiffs and foremen	0.9
Tractor drivers	0.7
Market gardeners	1.5
General workers	0.4

It certainly seems to be the case that the inquiry has met, with a substantial margin in hand, its original specification that the unit cost component of the national wages bill should be correct to within 1 per cent., and that they should be correct to within 5 per cent. for the occupational groups.

Earnings of Regular Hired Workers

The principal results under this head are shown in Table 2.

The various stages by which we have proceeded from the statutory minimum wage to earnings can be illustrated in more detail in the cases of two groups of regular hired full-time adult males—general workers, and all such regular males—for the year April, 1948, to March, 1949, when the minimum wage remained throughout at 90/- per week.

TABLE 3.—*Regular Hired Adult Full-time Males*

	1. <i>General Workers, April-March, 1948/9</i>	2. <i>All Workers, April-March, 1948/9</i>
1. Minimum wage, males 21 and over	90/-	90/-
2. Statutory basic hours	48	48
3. Hours worked for the minimum wage	47.2	47.2
4. Overtime hours worked	3.4	3.9
5. "Total hours" (see text below)	50.6	51.1
6. Regular contractual overtime	3/7	5/2
7. Premiums	3/2	6/3
8. Weekly contractual earnings	96/9	101/5
9. Net additional earnings	4/11	4/9½
10. Non-allowable perquisites	3d.	6½d.
11. Total earnings	101/11	106/9

Notes:—

- (8) Includes allowable benefits and advantages at statutory cash value. The figures are 5/1½ and 4/11.
 (9) Includes irregular overtime, piece-work (other than regular or contractual piecework) and output bonuses, but is less deductions for time lost and not paid for.
 (10) Examples, free pig-keep, Christmas bonus, etc.

The "total hours" quoted above include hours paid for but not actually worked during Bank Holidays, holidays with pay and sick pay time. Assuming full participation in statutory holidays and two days per annum of paid time lost due to sickness, these figures should be reduced by some 2½ hours per week to arrive at actual working hours.

The year to September, 1949, is the latest for which annual figures are available, but the story can to some extent be continued as far as March, 1950, as follows:

TABLE 4.—*Average Weekly Earnings of Regular Hired Full-time Adult Males, April, 1949 to March, 1950.*

Bailiffs and foremen	130/6
Cowmen	130/11
Other stockmen	118/7
Horsemen	117/4½
Tractor drivers	112/3½
Lorry drivers	127/10
General workers	106/11
Market gardeners	108/9
Ancillary workers	116/6
Average of the above	112/7
Minimum wage	94/-

The seasonality of farm workers' earnings can be illustrated from the following table:

TABLE 5.—*Average Earnings in the Quarter. Regular Hired Full-time Adult Males*

	Jan.—March 1949	April—June 1949	July—Sept. 1949	Oct.—Dec. 1949	Jan.—March 1950
General workers	97/5	104/5½	114/10½	104/8½	103/7½
All workers	99/-	110/4½	118/11½	110/5½	110/5½

The upward jump between the first and second columns is a result of the minimum wage being raised to 94/- and other changes made at the same time, although it is due partly to normal seasonal variations.

To refer to Table 2, it will be seen that there exists a definite and reasonably constant graduation in average earnings as among workers in the various occupational groups. This does not have its origin only in the differences in the number of hours worked per week; rather it is evidence of the existence of an employment ladder based largely upon varying requirements of skill and responsibility.

Another feature of interest suggested by Table 2 is that during this period the percentage increase in earnings—and indeed in some cases the absolute increase in remuneration—was less than that found in the average minimum wage. This was so in spite of the fact that changes in the minimum weekly wage were accompanied by corresponding increases in overtime rates. The explanation is to be found in the substantial reductions in the average weekly hours worked over the period of four years (see Table 6).

It is significant, however, that total working hours—and therefore earnings—seem to be more sensitive to changes in the hours related to the minimum wage (basic hours) than to the minimum wage itself. Thus basic hours and total hours remained constant from 1946–7 to 1947–8 for adult males, but fell considerably after the reduction in the statutory week in April, 1946, when the 48-hour week became general, and again after the change to a 47-hour week in March, 1949. This suggests that whilst workers may continue to maintain their total hours of work after a minimum wage revision, reductions in basic hours have not so far been accompanied by compensating increases in overtime hours. No evidence exists to suggest whether this is due to economy in the use of labour on the part of the employed, or to a reluctance on the part of the workers to forego the advantage of a shorter working week.

Hours of Work and Premiums

Table 6 sets out the estimated average hours worked per week by all classes of regular hired workers. These estimates were derived from records of the actual hours agreed under contract (including any overtime hours regularly worked), and from records of the monies received in respect of the time worked in excess of the hours agreed under contract. They are calculated after allowing for any contract time lost, and in respect of which wage deductions were made.

It is thought that the degree of error involved in this method of estimating irregular overtime from the financial data is slight, and would not appreciably affect the final averages. It should be noted, however, that no allowance has been made for time not actually worked during paid holidays and Bank Holidays, and no deduction has been made in respect of time lost through sickness, and for which payment was received. If it were assumed that every worker took full advantage of statutory holidays and received sick pay for an average of 4 days per year, the hours actually worked (net hours) would be about 2·8 hours per week less than those shown in Table 6. For example, this gives a figure of some 48·6 hours per week for adult males in 1946/47 and 1947/48,

TABLE 6.—*Average Weekly Hours of Work and Premiums of Regular Hired Agricultural Workers*

	Total Hours of Work				Premiums			
	1945-6 Hrs.	1946-7 Hrs.	1947-8 Hrs.	1948-9 Hrs.	1945-6 s. d.	1946-7 s. d.	1947-8 s. d.	1948-9 s. d.
Average basic hours per week*	48·35	48	48	47·45				
<i>Men (21 and over)—</i>								
Bailiffs and foremen	51·8	51·0	51·0	50·5	21 2	21 5½	21 10½	22 10½
Cowmen	57·2	56·1	56·0	55·5	7 3	7 3	8 2½	9 9
Other stockmen	54·7	53·1	52·5	52·4	6 5	5 9	7 1	8 0½
Horsemen	54·3	53·0	52·8	53·0	6 2	6 4½	5 11½	7 4
Tractor drivers	54·1	52·5	51·7	51·3	7 0	8 1½	6 4	7 6½
Lorry drivers	54·3	53·2	55·5	55·3	14 5	16 11	12 3	14 4½
General workers	52·2	50·8	50·9	50·5	3 0	2 11	2 8	3 3
Market gardeners	53·2	47·5	49·1	48·6	9 3	7 3	4 11½	6 3
Ancillary workers	51·5	50·5	48·5	48·6	10 11½	10 0	14 2½	12 2½
<i>All Hired Men</i>	53·1	51·4	51·4	51·0	5 9	5 10	5 6½	6 6
<i>Youths (under 21)—</i>								
General	51·5	50·3	50·7	50·2	2 7½	1 9	1 4½	2 6½
Other	52·3	50·5	50·7	49·9	4 8½	6 4½	4 6½	4 6
<i>All Hired Youths</i>	51·6	50·4	50·7	50·1	3 1	2 9½	2 0	3 0
<i>Females (incl. regular W.L.A.) †</i>								
(a) <i>Women—</i>								
General	49·3	48·7	49·2	49·1	2 8	2 0	1 8	2 9½
Other	49·6	48·3	48·7	48·3	5 4	4 4½	4 3½	5 7
<i>All Hired Women</i>	49·4	48·6	48·9	48·7	3 6½	2 11	2 11½	4 4½
(b) <i>Girls—</i>								
General	50·4	49·3	49·2	48·1	4 4½	2 11	1 0	2 9
Other	47·0	50·3	48·5	47·3	3 3½	1 6	2 1	1 5
<i>All Hired Girls</i>	48·9	49·9	48·9	47·6	3 11	2 1	1 5½	1 11½
<i>All Hired Females</i>	49·3	48·7	48·9	48·4	3 7½	2 9½	2 6½	3 9

* Hours related to the minimum wage.

† From October, 1945, to December, 1947, "Women" include all females of 18 years or over. From January, 1948, "Women" include all females of 21 years or over.

a figure which compares with 46·5 hours for all men in other industries in April, 1948, (*Ministry of Labour Gazette*, October, 1948)

Table 6 also gives some interesting information relating to the premiums paid to agricultural workers. A premium may be defined as a payment made in excess of that required by law for the hours worked, and may be regarded partly as the reward of industry, skill and the acceptance of responsibility, partly as a means of attracting and retaining labour at a time of labour shortage, and partly as an additional reward for undertaking longer working hours. They vary widely in amount, ranging in 1948-9 from about 23/- per week for bailiffs and foremen to about 1/6 per week for general girl workers.

Some year-to-year variations are observed but, in general, premiums seem to be increasing amongst the specialized categories of regular adult male workers, particularly for cowmen and other stockmen. This is no doubt a reflection of the increasing distaste on the part of the worker for work which involves a seven-day week. The figures for youths and girls may be affected by the age composition of workers included in the sample, and by the intensification of demand for regular labour in 1948-9 caused by the large scale reduction in the supply of Women's Land Army and other casual labour.

Conclusions

The period of ten years from the beginning of the war to the closing months of 1949 saw a substantial improvement in the money earnings and conditions of work of the agricultural workers. The minimum wage for adult males rose from 34/7 for an average week of some 50½ hours in 1938 to 94/- for a week of 47 hours in March, 1949, the 1938 figures being the average of the minimum county rates then in force. This is an increase of 172 per cent. in the weekly minimum, and of 191 per cent. in the minimum rate per basic hour.* It is estimated that the actual earnings per week for adult males were approximately 39/- per week in 1938, whilst by March, 1950, they had reached the region of 112/6 per week. This is an increase of nearly 190 per cent. in money earnings. At the same time the number of paid holidays and Bank Holidays allowed have increased considerably since pre-war, and this, together with the decrease in the number of hours for which payment was made, would indicate that earning rates per hour actually worked have increased to a still greater extent. Unfortunately no reliable information is available on the subject of pre-war hours of work, but 53 hours per week would not be an unreasonable estimate as compared with the present-day average of about 51 hours. If allowance is now made for lost time due to statutory holidays (3 days in 1938, and 13 days now)†, the net hours actually worked will average approximately 52½ hours per week, and 48½ in 1950. On this basis earnings per net hour have increased by 212 per cent. from nearly 9d. per hour to nearly 28d. per hour. If no allowance is made for paid holidays, the earnings per hour have increased by 200 per cent. from 1938.

Without entering into a discussion of comparative earning rates in agriculture and in industry, it may be noted that the position of the agricultural worker relative to his industrial counterpart has changed considerably since pre-war years. The weekly earnings of adult males in industry increased from 69/- in October, 1938, to 142/8 in October, 1949, a rise of 107 per cent., whilst their hourly earnings increased by 110 per cent. over the same period.

Acknowledgments

We would like to refer with gratitude to our colleagues, the Wages Inspectors, on the high quality of whose field work we completely depend. We would mention also, and in the same sense, an ex-colleague, Mr. C. W. Roberts, who was largely responsible for the design and execution of this inquiry in the earlier years.

Reference

Yates, F. (1949), *Sampling Methods for Censuses and Surveys*. London: Griffin.

* "Basic hours" are here interpreted as those hours related to the minimum wage.

† 1938, three Bank Holidays (county average); 1950, six Bank Holidays and seven paid holidays.

1951]

THE SOURCES AND NATURE OF STATISTICAL INFORMATION IN SPECIAL FIELDS OF STATISTICS

THE AGRICULTURAL STATISTICS OF THE UNITED KINGDOM

By D. K. BRITTON and K. E. HUNT.

Contents

Page

• • Introduction	59
• The Agricultural Returns	60
The National Farm Survey	61
The Farm Management Survey	62
Land Use and Classification	63
Number and Classification of Holdings	65
Rents and Land Values	67
Employment and Earnings	67
Machinery	72
Electricity and Water Supplies	74
Tenant's Capital	74
Agricultural Credit	74
Crop Acreages	77
Livestock Numbers	78
Yields per Acre	79
Yields per Head and Gross Livestock Production	81
Prices	82
Price Index Numbers	84
Utilization and Output	87
Utilization of Agricultural Products	88
Current Estimates of Output	90
Net Income	91
Miscellaneous Statistics	92
Summary and Conclusions	94
Bibliography	

Introduction

In the official report on the Census of Agricultural Output taken in 1925, the Ministry of Agriculture and Fisheries published a review of the available statistics relating to agriculture in England and Wales, and a brief survey of such statistics up to 1925 (2). No attempt at such a comprehensive review appears to have been made either before or since that date, although useful summary descriptions have been written from time to time (46, 47, 48, 49), and the history of the development of some of the more important series has been told (48, 50, 51).

The present scope of agricultural statistics cannot be concisely defined. No single publication in the United Kingdom illustrates the full range of subject-matter, but the *Agricultural Statistics* published annually by the United States Department of Agriculture shows what a wide field is now covered by the term. In addition to crop acreages, livestock numbers, crop and livestock production and prices, the volume contains statistics of farm population and employment, farming income and expenses, amounts of machinery and fertilizers used, family living costs, farm taxes, bank loans to farmers, weather reports and many other items.

In the United Kingdom at the present time a great variety of current or recent numerical information about agriculture appears in print every year. It is issued by many agencies, including Government departments, semi-official bodies like the Milk Marketing Board, research organizations, farmers' unions, trading and commercial concerns and banks. In spite of the extension of the coverage of agricultural statistics which has taken place in recent decades, the demand is by no means satisfied. Some sectors of the field are covered in insufficient detail, or not at all. Interest, whether popular or academic, is continually shifting from one aspect of agriculture to another. In one period the emphasis falls on physical productivity, output per man and the effects of mechanization, in another on prices, costs, profits and wages.

In response to changes in current requirements, existing statistical material is continually being interpreted and arranged in new ways, but there remain many questions which cannot be answered without making inquiries of a fresh kind. In some cases new methods of collection or estimation have evolved. The results are not always presented as deliberate and permanent extensions of the existing system, nor are they always published through the recognized channels of official statistical information. The net would have to be cast very wide to include them all.

This gives rise to the problem of deciding at what stage these emergent statements of numerical facts about agriculture become part of "the agricultural statistics of the United Kingdom"—a phrase which suggests a body of information which possesses some degree of continuity of form and content. The principle applied here is that once an inquiry has been put on a systematic footing, with reasonable consistency of method and repetition at intervals of time or over several areas of the country, the results may justifiably be called "agricultural statistics." A further criterion is that the new material should supplement in an important respect the national statistics already available, and take its place with them in presenting a coherent picture.

A great deal of the information available has not been published on a uniform basis for the whole of the United Kingdom. Where data are known to relate only to Great Britain, England and Wales, Scotland or Northern Ireland this has been indicated, but the inconsistencies between the statistics for these areas are formidable, and it has not been possible to enumerate here all points of difference.

The existence of statistics relating to smaller administrative units such as counties, regions or provinces has also been mentioned.* Moreover, the fact that information of a certain kind is not nation-wide in scope has not in itself been considered sufficient reason for its exclusion. Reference has been made to local data if these seem to delineate some important feature of British agriculture which has not otherwise been made the subject of statistical study.

The text and bibliography refer not only to sources of statistics, but also to books and articles which give useful interpretative comment on standard official series. In some cases reference is made to an unofficial publication as though it were the primary source of the statistics in question, when in fact they came in the first place from a Government department. This is because in recent years, in order to obviate delays in printing which have resulted from wartime arrears and the great increase in the current output of official information, much useful material has been given out by Government departments in the form of Press Notices in the first instance. After a long interval these are usually consolidated in an official report, but in the meantime the general public must rely on newspapers and periodicals to pass on the information.

First it will be helpful to describe three important contributors to the fund of statistics now available, viz., the Agricultural Returns, the National Farm Survey (52) and the Farm Management Survey (27 to 32).

The Agricultural Returns

Under compulsory powers given by Section 78 of the Agriculture Act, 1947† (and a corresponding Act for Northern Ireland), the agricultural departments collect returns from all occupiers of over one acre of agricultural land.‡ The Act prescribes a very wide range of subjects in relation to which information may be required. These include land use, production, equipment, stocks, methods and operations, marketing, employment of labour (including remuneration and hours worked), rent, and dealings in land. The Act lays down, however, that the occupier shall not be required to furnish any balance-sheet or profit and loss account.

Similarly wide powers of collection were given under the Agricultural Returns Order, 1939, but before that date (under the Agricultural Returns Act, 1925) occupiers could not be compelled to give information except concerning the acreage of various crops, the numbers and descriptions of livestock kept, the numbers and description of workers employed and whether the occupier

* For many years the Ministry of Agriculture and Fisheries prepared statistics for groups of counties, called divisions. The boundaries of these divisions did not, however, coincide with those of other groupings now in use, such as the provinces of the National Agricultural Advisory Service, the regions of the Ministry of Food, and the regions of the Ministry of Labour and National Service. For details, see (2, 6) and (53, 443).

† Statutory Instrument 1948, No. 2294, gives effect to some of these powers.

‡ One-quarter of an acre in Northern Ireland.

1951]

was owner or tenant. Any supplementary information was collected on a voluntary basis. Prior to 1926 all returns were made voluntarily, except in the period 1918 to 1921 inclusive, when they were compulsory under the Corn Production Act, 1917.

The Agricultural Returns provide the fundamental information required for almost any study involving agricultural statistics. The acreage of agricultural land, the area under the principal crops and the number and description of livestock kept—these items have been the subject of annual inquiry without interruption since 1866, and statistics of the number of persons employed on agricultural holdings have been collected annually since 1923.

Besides the main annual Returns which are collected in June and require answers to some 140 questions,* a winter census of livestock has been held in England and Wales in December annually since 1935, and since 1939 there has been a quarterly return of livestock in Great Britain.

A central register is kept of all holdings of over the statutory minimum acreage, and local officers of the agricultural departments have the duty of notifying changes in the area or in the occupancy of these holdings, and of generally maintaining the accuracy and completeness of the register. This is a very difficult task, and holdings are liable to be omitted or duplicated. It is known that before 1941 (when the rationing of feeding-stuffs became associated with the completion of an Agricultural Return) many small holdings escaped enumeration, but their total area in England and Wales was not significant in comparison with the total enumerated area of over 30,000,000 acres. In 1941 many occupiers made Returns for the first time, but they were more important in numbers than in the total production which they represented (14, 6).

The quarterly Returns are summarized only by counties, but the June Returns are summarized by parishes. Parish totals are not published (there are over 12,000 parishes in England and Wales), but they are available for consultation by research workers and other persons, subject to certain conditions designed to preserve the confidential nature of individual Returns. Duplicate copies of the Returns are used by the County Agricultural Executive Committees to work out county cropping targets, feeding-stuffs requirements, etc.

No attempt has yet been made to obtain estimates of county or national statistics for the items of the Agricultural Returns by means of a sample inquiry, i.e., by sending forms to a proportion of the holdings on the register.† Such a procedure has produced good results in the United States, where even 5 per cent. samples have been found sufficient for some purposes. The advantages are not, however, so impressive in a smaller country in which a very wide range of farming conditions and systems is to be found. Nevertheless, the wording of the relevant clause in the Agriculture Act, 1947, may be read as a provision that inquiries could be confined to a selection of holdings, at the Minister's discretion, and the question has been considered (11, 6).

Preliminary national totals, based on the results of the parish or county summarizations, are usually published in the national press about two months after the date of the census. Statistics for the main items appear in the *Monthly Digest of Statistics*, and fuller details are given from time to time in the respective journals of the Agricultural Departments.

Recently there has been considerable delay in the publication of county figures, owing to difficulties in printing. Before 1939 it was customary for the county statistics relating to a particular June census to be published in the following year, in the volumes of "Agricultural Statistics" of the respective countries. At the present time there is a delay of several years in the appearance of these detailed figures (14, 15).

National Farm Survey

In carrying out their war-time task of ensuring maximum food production from the farms of England and Wales, the County War Agricultural Executive Committees found it necessary to assess the contribution which each farm could reasonably be expected to make. This involved personal visits and inspections, since the Agricultural Returns were quite inadequate as a basis for estimating the *potential* productivity of the farms in question.

It was decided to carry out an extended Survey during the period 1941 to 1943, in order to

* A reproduction of the form of Return used in England and Wales in June, 1941, appears in (53, 409-11).

† The *National Farm Survey Report* (see below) was based on a sample *tabulation*, but there was a complete enumeration.

collect, from every farm in the country, data about the tenure of land, the conditions of the farm (layout, situation, farmhouse, buildings, drainage, etc.), the supply and use of water and electricity, the standard of management and the progress of the ploughing up of grass fields.* A plan of each farm was also to be prepared, showing boundaries and fields. It was further arranged that the Agricultural Returns of June, 1941, should include special questions about rent and length of occupation.

The detailed information was obtained in the course of farm visits by officers of the County War Agricultural Executive Committees or their agents. Most of the qualitative information recorded was based on the judgments of field observers, while answers to the quantitative questions were usually supplied by the farmer. Completed records were scrutinized by Provincial Advisory Economists attached to Universities or Agricultural Colleges. Comparison was made with the farmers' Agricultural Returns and many queries had to be settled.

Holdings of under 5 acres were not included in the Survey. It was decided that the extra work involved in their inclusion would have been excessive in relation to the information gained.

The statistical results of the Survey were published in 1946 in a Summary Report (52). The Minister of Agriculture described the Survey as "a cross-section of the entire industry taken at a moment of time", and the Report as "a mine of information capable of being worked for many years". Tables are given on a national, regional, and county basis. The Report was based on a 14 per cent. stratified random sample of all the holdings comprising the "population". The tabulation and analysis of the data relating to the 40,000 holdings in the sample were carried out with the aid of punched-card machinery. Tests were made of the adequacy of the sample, and it was clear that the sampling errors could not affect the main implications of the results.

The Report states that "requests for access to this material for research purposes will be sympathetically considered, so far as is compatible with fulfilment of the undertaking that all particulars relating to individual farms will be regarded as confidential". It points out that the tables given represent only a small part of the useful information which mechanical tabulation could provide from the data on the cards. Certain national and provincial studies have been published which make fuller use of the Survey data than was possible for the purpose of the Summary Report, e.g. (54, 55, 58, 59). Statistical analysis has naturally been concentrated mainly on the quantitative data obtained. In collecting and comparing the qualitative records the lack of precise and generally recognized standards created serious difficulties.

The National Farm Survey was not extended to Scotland, but a more limited Agricultural Survey of Scotland was undertaken (60). This "was concerned almost entirely with the potentialities and deficiencies of the land itself". The farmer and his equipment were not made the subject of investigation. Records were collected and tables prepared to show the potential yield and stock-carrying capacity of various types and areas of land, assuming the highest standards of management. Estimates were also made of the number of farms suitable for the growing of certain crops. The Survey was not complete, but covered a random sample of farms stratified by size, and amounting to 14 per cent. of the total number of farms of over 5 acres.

Farm Management Survey†

In the National Farm Survey and (up to the present time) in the Agricultural Returns, inquiry has been confined to *physical* and *organizational* characteristics of farms, to the exclusion of *financial* data. Nothing could be gathered from these sources about the general prosperity of agriculture, the level and variation of farm incomes, costs of production or efficiency in the use of labour and capital. To obtain information of this character the Farm Management Survey was initiated in England and Wales in 1936. It is a continuous survey, and has been carried on without a break since that date. Before 1936 agricultural economists working at Universities and Colleges had provided valuable information for particular localities, but these had been irregular and unco-ordinated and they lacked consistency of method.

The basis of the Survey is farmers' accounts, and under the present arrangements a Conference

* Plans have now been made for all farms in England and Wales to be surveyed at regular intervals, on a standard system of inquiry similar to that described here.

† Since this text was prepared the Ministry of Agriculture and Fisheries has published a detailed report on farm incomes in England and Wales, 1944-45 to 1947-48, based on the Farm Management Survey (H.M.S.O., January, 1951, 10s. 6d.).

1951]

of Provincial Agricultural Economists determines how many accounts are required from each of 10 provinces, in the light of the total number of farms and the variability of conditions in each province. Without such information it would be impossible to give any precision to judgments about the profitability of different types of farming, the normal level of production costs and the relative importance of the various elements making up those costs, the relative efficiency and economy of production on farms of different types and sizes, the effect of price adjustments on farm incomes and farm outputs, and many other important questions.*

Data are collected on purchases of livestock and livestock products, payments for feed, seed, fertilizers, labour and other outlays made in the process of production; the acreage, production and sale of crops, sales of livestock and livestock products and other sales; births and deaths of livestock; and an opening and closing inventory of crops, machinery, livestock and equipment.

- The total number of farms contributing to the Survey each year has been about 2,000 to 3,000.
- Methods of sampling and collection vary. Farmers are under no obligation to participate, and the fact that the Provincial Agricultural Economists, who are responsible for collecting the data, have to rely on the willing co-operation of farmers means that they cannot hope to obtain a completely random sample. As a rule it is more difficult to obtain adequate financial data from the smaller farms. In the absence of a complete set of accounts it is often possible to build up the required body of information by question and answer, and by the use of pass books, cheque book counterfoils, invoices, etc., and without using this method the smaller holdings would be very much under-represented. As it is there is an appreciable predominance of larger farms. This is partly deliberate, but efforts are made to see that all types and sizes of farms are represented. The general principle is to employ random sampling within pre-selected geographical areas or within pre-selected groups of farms, with subsequent adjustments and substitutions according to what is practicable.

The Survey is concerned with "commercial undertakings where the farmer is wholly or mainly occupied with the work and management of his farm." Small part-time farms, hobby farms and some specialized farms are omitted.

It cannot be claimed that a sample of 2,000 to 3,000 farms, in a country containing such a wide variety of agricultural conditions as exist in England and Wales, is adequate to give more than general indications of the position. The Survey farms have generally accounted for only 1 or 2 per cent. of the cultivated area of England and Wales, and within that sample some regions and farming types have been more fully represented than others (27). For this reason the reports have tended to avoid the presentation of national averages, and "in any case, some factors vary throughout the country as a whole in such a way that their arithmetic means have little value" (27, 6). Nevertheless, the Farm Management Survey undoubtedly goes a long way to fill what was previously a serious gap in the agricultural statistics of England and Wales.

Inquiries of a similar nature have been carried out in Scotland annually since 1928/29, "to estimate the profitability (or otherwise) of farming in Scotland" (33 to 44). The number of farms participating in 1944/45 was 559. The data collected and the tables published are concerned with the general description of farms, their economic organization, their financial results, the factors underlying differences in profits and the adjustments suggested by present levels of prices and costs.

Farm accounts are also collected and analysed in Northern Ireland, and the reports are in most respects comparable with those published in England and Wales and in Scotland (45). In 1948/49 data were collected from 348 farms.

Land Use and Classification

The total land area of the United Kingdom amounts to 59,554,000 acres. In June, 1949, the area represented by the Agricultural Returns, together with common rough grazing land which is not subject to these Returns, was 48,234,000 acres. Of this, 31,056,000 acres were returned as being under crops or grass, and this area is often described as the "cultivated area". "Cultivated" is here used in the wider sense of "having had labour and attention bestowed upon it" (*Oxford English Dictionary*), and not in the narrower sense of "ploughed". Much of the grass

* Reference is made to the National Farmers' Union Farm Accounts Scheme under *Employment and Earnings* below (p. 72). See also (138).

included in the cultivated area never comes under the plough. The term "arable", which is also rather ambiguous (53, 83, 86), is used in the agricultural statistics of the United Kingdom to describe land under crops, fallow or temporary grass (i.e. clover and rotation grasses), and in June, 1949, this amounted to 18,369,000 acres. "Tillage" is the term reserved for the area under crops (other than temporary grass) and fallow*; the 1949 figure was 12,643,000 acres.

The total area of land being used for agricultural purposes is somewhat greater than that covered by the Returns, since holdings of one acre or less in Great Britain are at present exempt from enumeration. This point is particularly important when horticultural produce and the production of eggs are being considered. These numerous small-holdings and allotments amount to at least 100,000 acres, and in any consideration of the total food-producing area of the country, private gardens would also have to be taken into account (53, 189-191).

Changes in the total area covered by the June Returns do not always provide a reliable guide to the real trends in land use. Artificial increases in the agricultural area may be shown, e.g., when land which had previously been overlooked comes into the Returns, although no change in its utilization has occurred. In 1941 some 250,000 acres were added to the total area returned in England and Wales, as a result of new regulations governing the issue of rationed feeding-stuffs. The true position in 1941, however, was probably a loss, not a gain, in the agricultural area, owing to widespread requisitioning by the Service departments.

There are other reasons why great care is necessary in using the Agricultural Returns to obtain knowledge of the net annual loss of agricultural land to building and other purposes. These were discussed in an article in the *Journal of the Ministry of Agriculture and Fisheries* (August, 1949). In every year there are gains to be set against losses, and entries on both sides of the account often represent re-classification rather than changes in land use. It is also important in this context to remember that the quality of land varies. Much of the land that is recovered for agricultural purposes (e.g., military training areas restored to their former uses) may consist of very rough land, whereas land surrendered for building or for aerodromes is often of high quality. In some instances confusion has arisen over the identification of common rough grazings, as distinct from rough grazings over which the occupier has sole grazing rights. Here duplication is apt to occur. Indeed, in the case of the county of Brecon the Agricultural Statistics for 1939 showed that the total area included in the Agricultural Returns, together with the official estimate of the area of common rough grazings, amount to more than the total area of the county (including towns, villages, roads, etc.) as given by the Ordnance Survey! (See also (53, 59) and (2, 9).)

Similar difficulties arise in considering the long-term changes in the distribution of the agricultural area between arable, permanent grass and rough grazings. Apparent transfers between these categories, which might superficially be attributed to land improvement, shifts in the margin of cultivation, re-seeding with permanent grasses, etc., may in fact be due to changes in the official definitions of the respective categories or to changes in farmers' interpretations of the terms used. It has proved extremely difficult in practice to arrive at descriptions of the different types of grassland which will be uniformly interpreted throughout the country (53, 25, 65, 145).

The statistics of the utilization of land for agriculture in Great Britain since 1866 are conveniently summarized in (53, Appendix VIII).

Before the 1930's there was very little statistical information about the nature and utilization of the area not covered by the Agricultural Returns, although in 1925 the Ministry of Agriculture and Fisheries made tentative estimates of the area in England and Wales "not used for any agricultural or productive purpose, but which might be so used" (2, 6). There is, however, an important source of more recent information about land use in the Land Utilization Survey of Britain. This was set up in 1930 under the auspices of the London School of Economics and was directed by Professor Dudley Stamp. The main object of the Survey was to record on detailed maps (six inches to one mile) the use of every acre in Great Britain and the Isle of Man. A similar survey was later carried out for parts of Northern Ireland. A large part of England was covered in 1931 and 1932, Wales and Scotland followed, and the whole Survey was completed by 1939. A separate report has been published for each administrative county. The following categories of utilization were distinguished: arable land; meadowland and permanent grass; heathland, moorland, commons and rough pastures; forest and woodland; houses with gardens; orchards;

* All orchards on agricultural holdings are included under tillage.

nurseries; and land agriculturally unproductive. The results are presented, in acres and in percentage distribution, in (53, 197-200). Each county report has an Appendix showing official statistics of land use since 1866 and a summary of the results of the Survey compared with the official statistics for the same period. Some of the apparent discrepancies were large, and although they were in part due to differences in scope of inquiry and in definition of the categories, it was also claimed that "the Land Utilization maps, being based on observation, are . . . likely to be more accurate than the official figures" (53, 27).

The Survey also carried out an investigation into types and qualities of land. The purpose was to distinguish good, medium and poor agricultural land, and under these broad headings ten types were enumerated. The residue was described as "land closely built over" (53, 366).

In 1939 the Land Utilization Survey published a map prepared by the Ministry of Agriculture showing the geographical distribution of the main types of farming organization and practice in England and Wales. It would be possible for subdivision to continue almost indefinitely, but it was considered that use of twenty types in England and Wales, grouped under "pasture", "intermediate" and "arable" types, was sufficient to convey a reasonably true impression. A map for Scotland prepared and published by the Land Utilization Survey distinguishes five predominant farming types. The classification of *holdings* by type is dealt with in a separate section below.

The value of all these land use studies would be greatly enhanced if means could be found of repeating the surveys at intervals. It is possible that in future the need will to some extent be met out of the material collected by County Planning Officers under the Town and Country Planning Act, 1947, which states that maps should be prepared showing the predominant uses of all land in the planning area.

The *National Farm Survey Report* (52) presents data on type and natural fertility of soil, classifying soil as heavy, medium, light, peaty fen or peaty bog, and as being of good, fair, or bad natural fertility. Counties were graded by an index of natural fertility, based on the Survey records. The results agree quite closely with those obtained by Professor Kendall in 1939 on the basis of crop yields (110), even though in the latter case pasture was left out of account. The Survey also provided data on the acreage of derelict land in England and Wales, such land being that which had been neglected or badly managed and was therefore producing little or nothing of value to the farmer, but which was considered to be capable of reclamation.

Statistics of the forest area of the United Kingdom are given in the *Annual Abstract of Statistics*, No. 86, 1938-1948.

Number and Classification of Holdings

In 1945 there were 529,106 holdings of over one acre of agricultural land in the United Kingdom.* This figure relates to the number of separate Returns tabulated, and should not be quoted as the number of "farms" in the sense of separate business units. "There is a good deal of pasture land in separate and detached fields, or in parks, or attached to residential properties which is separately and quite properly returned, but these parcels of land may or may not be farmed for business" (2, 8). Moreover, the number of holdings exceeds the number of individual occupiers, since it is not unusual for an individual occupier to have two or more holdings (59, Ch. I, 63, Ch. II). Such an occupier is instructed to make a separate Return for each holding farmed separately. The question of distinguishing holdings from farms and occupiers from farmers is discussed more fully in the *Report on the National Farm Survey of England and Wales*, and elsewhere (52, 6-14; 2, Ch. VII; 62, Ch. VIII). The distinction becomes important as soon as the concept of "average size of farm" is introduced.

The chief classifications of holdings are by size, type of farming and form of tenure. A statement of the number and acreage of holdings in various acreage size-groups appeared in the *Agricultural Statistics* for 1870, and similar tables have been given at frequent intervals since that date. The most recently published figures relate to 1945 (64, 29).† At that date only 2.8 per

* This excludes some 9,000 holdings in Great Britain which consisted solely of rough grazings. In Northern Ireland the census also enumerates holdings of $\frac{1}{2}$ acre and not exceeding 1 acre, but these are not included in the above figure.

† Only the numbers of holdings in each group are given. For the latest figures of the total acreage comprised by the holdings in each group, reference must be made to (14, 196, 6, 72-74 and 4, 54). County figures are also available.

cent. of the holdings in the U.K. were of more than 300 acres, but they accounted for 22–23 per cent. of the area under crops and grass. At the other end of the scale 19 per cent. of the holdings were in the group “above 1 and not exceeding 5 acres”, but they accounted for less than 1 per cent. of the total area. In using these statistics it should be remembered that the basis of classification is the “crops and grass” area of the holding. The inclusion of rough grazings would reduce the numbers of smaller holdings and increase those of the larger.

“Smallholding” written as one word or thus, “Small Holding”, is a technical term signifying not simply a holding of limited size, but also a particular form of organization and type of occupier (66, Chs. III and IV). Historically the term has come into use following the formulation of a national policy for the settlement of men on the land as farmers on their own account. The essential point of difference between the smallholding proper and the small holding defined on the basis of size-classification is that a public authority enters at some stage into the provision and administration of the former, operating within the terms of the Small Holdings and Allotments Acts, 1908 to 1931, and Part IV of the Agriculture Act, 1947. Statistics of the number and acreage of smallholdings provided by County Councils and County Borough Councils will be found in a recent report of the Smallholdings Advisory Council (67). In earlier years information was given in the annual reports of the Land Division of the Ministry of Agriculture and Fisheries (68).

Classification by acreage only does not produce groups of farms which are at all homogeneous. The farms in one size-group will differ in respect of their principal products, their labour complement, the quality and productivity of land and many other characteristics. Even as an indication of “size” of business, acreage alone is an unreliable guide. Other methods of grouping have therefore been devised. Agriculture may be regarded as consisting of many separate industries, and expressions like “the dairying industry” and “the poultry industry” are frequently used. It would be convenient for many statistical purposes if all the holdings could be classified under one or other of these industries, but unfortunately the majority of holdings produce a range of commodities and cannot be identified in this way. One broad basis of classification which can be generally applied refers to the relative proportions of arable land and pasture on the holding. In 1885 and 1908 all holdings in Great Britain were divided into three classes, viz., (a) wholly arable; (b) wholly pasture; and (c) mixed (arable and pasture) (1, 22–25). In 1924 a further analysis was carried out for England and Wales, but the basis was changed to (a) farms consisting of at least 70 per cent. of arable land; (b) farms consisting of at least 70 per cent. of pasture land; and (c) mixed farms (the remainder). Specialist fruit and vegetable farms and poultry farms and holdings of under 20 acres were excluded from this analysis. Tables were prepared to show the distribution of holdings of each type by size of holding, and the density of various kinds of crops and livestock per 100 acres of crops and grass on holdings of the various types and sizes. County figures were given showing what proportion of the total acreage was occupied by “arable farms”, “pasture farms” and “mixed farms” respectively (2, Ch. VII). The analysis was repeated for 1930, but county tables were not published (*Agricultural Statistics*, 1932).

For the purpose of the 1939 Types of Farming Map (mentioned above) the whole of England and Wales was divided into 200 areas, each of which could be more or less identified with one or other of seventeen major Types of Farming (e.g. “Dairying with other enterprises”, “Mixed Farming with Dairying”, “Corn and Sheep, with Cash Crops”, etc.). It was realized that within each delineated type-area there would be a minority of farms which did not conform to type. Nevertheless, when the June 4th, 1941, Returns were being analysed in connection with the National Farm Survey Report it was decided to classify the 290,000 holdings included in the Survey according to their location in the seventeen type-areas. Tables in the Report show for each type of farming the number, total area, size-distribution and average size of holdings, the proportion of such holdings having various numbers of cows, and the distribution of cropping and the density of stocking.

Since the National Farm Survey Report was prepared there has been no official tabulation of holdings classified by type of farming, but the National Farmers’ Union, which collects a wide range of data through its Farm Accounts Scheme, classifies the participant farms according to acreage and “revenue types”. In recent years this source has provided some interesting tabulations relating to about 4,000 farms, and showing the amounts of farm machinery, labour, crop acreages, livestock numbers, receipts, expenses and net output which are associated (on the average) with farms of various sizes and types. Here the types are distinguished according to

the proportion of total revenue which is derived from specified products. The basic groups are Dairy, Arable, Livestock, Fruit, Poultry and Horticulture, but provision is made for farms showing combinations of these, i.e., where none contributes more than 60 per cent. of the farm's total revenue. (See *N.F.U. Information Service*, monthly.)

The expression "marginal farm" is one which is now frequently used in agricultural circles. There have been few attempts at its definition in statistical terms, but a wide range of statistical data about marginal farms in Scotland has been collated and published by the Department of Agriculture for Scotland (93); see also (94). On April 5th, 1950, the Minister of Agriculture told the House of Commons that a Survey was being made to ascertain the approximate extent of marginal land in England and Wales. The National Farmers' Union has also inquired into "the size of the problem in terms of acreage".

The distribution of holdings and acreage between owner-occupation and tenancy has been the subject of inquiry on a number of occasions. The most recent tabulation for England and Wales relates to 1941, when special questions were added to the June Returns for use in connection with the National Farm Survey. The results show that at that date 33 per cent. of the crops and grass area was owner-occupied. Figures for Scotland are given in *Agricultural Statistics* 1939-1944, and they indicate that in 1944, 31 per cent. of the crops and grass area of Scotland was owner-occupied. Earlier figures for both countries will be found in the *Agricultural Statistics* for 1924, and reference to the question was also made in the *Agricultural Output* reports of 1925 and 1930. Figures relating to 1950 are expected to be published following the inclusion of special questions in the March, 1950, *Agricultural Returns*.

Rents and Land Values

As a general rule no question relating to occupiers' expenses and requiring an answer in monetary terms has been included in forms sent to farmers, but an exception was made in June, 1941, when occupiers in England and Wales were required to state the actual rent payable during that year or, in the case of ownership by the occupier, an estimate of the annual rental value. Provision was made for cases of part ownership and part tenancy. The results of this inquiry are given in the National Farm Survey report, and are described as "certainly the most comprehensive and probably the most accurate information on agricultural rents yet available" (52, 23). Earlier figures published in 1925 and 1931 were based on Crop Reporters' estimates, expressed as average rents per acre for holdings of different sizes and types (2, 5). Further indications of the general level and course of rents are provided by the Farm Management Survey reports (27 to 32) and surveys carried out jointly by the Central Landowners' Association* and the Ministry of Agriculture and Fisheries (69). For a detailed study of one province, see (55, No. 2).

Some rent statistics for Scotland are given in an official report published in 1948 (70) and in an article of the same year (71). See also (33 to 44). Figures for Northern Ireland may be obtained from articles on financial results of farming, published from time to time in the *Monthly Agricultural Report* of the Government of Northern Ireland.

There is little information of an organized character on the subject of the capital value and sale price of agricultural land, and in this field British official statistics are a long way behind those of some other countries. Crop Reporters in England and Wales made estimates in 1925 and 1931 "on the basis of the actual prices at which any sales had recently been effected", and tables were prepared showing the results by size, type and geographical location of holdings; but apart from this, no official figures appear to have been published. The results of auction sales of farm land between 1918 and 1939 have recently been summarized in order to obtain an indication of the trend of farm land prices (72), and earlier a study was made of rents and prices in South Wales (73).

Employment and Earnings

There are three main sources of information on the numbers and categories of persons engaged in agriculture: (a) the *Agricultural Returns*, which included questions on the employment of

* Now the Country Landowners' Association.

Labour in 1921, annually from 1923 to 1942 and quarterly since September, 1942; (b) the Occupation Tables and the Industry Tables of the Decennial Population Census, last taken in 1931; and (c) the Ministry of Labour's statistics of insured employment (and unemployment).

In the Agricultural Returns are included all persons (British and foreign) employed on agricultural holdings on the day of the return, all regularly employed workers absent through sickness or holidays, and occupiers' partners if these are engaged in any work on agricultural holdings. Occupiers and their wives are *not* included, nor are office staff, domestic servants (unless they do at least 30 hours farm work a week), dependents of the occupier not engaged on farm work, or children enrolled at school. Workers are returnable whether or not they are paid wholly by wages. Bailiffs, foremen and grieves doing supervisory work are included in the Returns. People working at ditching, drainage and other maintenance and repair work, threshing, thatching, and marketing the produce of the holding in question are returnable, but not gardeners or groundsmen spending most of their time on pleasure, recreation or ornamental gardens. Casual workers working on the holding on the day of the return are included, "even if they have never worked on it before and may never do so again". This is to cover labour supplied by County Agricultural Executive Committees, contractors and gangmasters. Workers who are regular but part-time are to be returned as casual. It should be noted that the instructions regarding the return of labour were extended and clarified in September, 1948, and some degree of discontinuity in the series is likely to have resulted.

The published statistics distinguish regular from casual workers and males from females, and in the case of males separate figures are given for certain age-groups. For some years prisoners-of-war formed a separate category, and members of the Women's Land Army have been separately returned since June, 1944. In both cases the persons recorded are those working on holdings, and their number is generally appreciably less than the total on the roll (14, 5-6).

These statistics, used in conjunction with the rest of the information provided by the Agricultural Returns, are of great assistance in analysing the past and present structure of the agricultural industry. A number of studies have been made to show the relationships existing at various times and places between numbers of workers and acreage of holding and other farm characteristics (e.g. 1, 20; 2, 105 and 148; 3, 91; 4, 64 and 84; 52, 48; 75; 76; 77).

There are, however, a number of important questions which cannot be answered by reference to the Agricultural Returns of labour employed. How many farmers are there in the United Kingdom? How many sons and daughters of farmers are working on farms, and how many farms are worked entirely by family labour? How many agricultural workers were not employed on the date of the census? What addition should be made to the Returns to allow for persons employed on holdings of 1 acre or less (e.g. in glasshouse production)? What proportion of the workers returned are special types like tractor-drivers, stockmen, shepherds, horticultural workers, etc.?

An attempt to answer these questions can be made on the basis of the results of the 1931 Population Census, although it is obvious that any conclusions reached can have only limited validity for 1950. On the question of the number of farmers, it has already been pointed out that not every agricultural holding constitutes a separate farm business. To some occupiers the management of their holdings is not their chief concern, in respect either of time spent or of income received. It is therefore not surprising to find that while there were 392,000 holdings of over one acre in England and Wales in 1931, only 248,000 persons, when asked in the Population Census of that year to give their main occupation, described themselves as farmers. Among the factors contributing to this difference are the following: (i) The enumeration of 71,000 holdings of above 1 but not exceeding 5 acres, many of which are more or less nondescript parcels of land which could never be called farms, and which may "comprise not more than one or two fields entirely without buildings and used solely for grazing purposes in connection with businesses other than farming, such as butchers', bakers' and greengrocers' businesses" (52, 7). The same would apply to a certain number of holdings of over 5 acres. (ii) The existence of part-time, spare-time and hobby farmers who are the legal occupiers of agricultural holdings and in some cases reside there, but who would have entered themselves under some other occupation (i.e., their main trade) in the Population Census. Many of these work for other farmers most of the time. (iii) The distinction in the Occupation tables between farmers and "gardeners, nurserymen, seedsmen, florists", a group numbering 221,000, which included 11,000 persons describing

1951]

themselves as of managerial status and a further 35,000 working on their own account. A proportion of these would be occupiers of agricultural holdings, mostly small in acreage.

The National Farm Survey Report succeeded in clearing away some of the difficulties by classifying all holdings of 5 acres and over according to the type of occupier (full-time, part-time, etc.), and came to the conclusion that some 216,000 holdings in England and Wales were occupied by full-time farmers farming for a living. The average size of such holdings was 99 acres of crops and grass. There were also 32,000 holdings occupied by part-time farmers who were defined as having some other occupation besides farming, but for whom farming was still the main occupation and source of livelihood. In this group the average size of holding was 43 acres. It is an interesting coincidence that the total number in these two groups (248,000) is the same figure as that given ten years earlier for the number of farmers enumerated in the Population Census. The Farm Survey, however, listed a further 8,000 "hobby farmers" who, though not dependent on farming for a living, would in many cases be devoting more time to farming than to any other pursuit. It seems likely, then, that some 256,000 persons in England and Wales would have been returnable as farmers if a Population Census had been taken in 1941.*

The White Paper on *National Income and Expenditure of the United Kingdom, 1946 to 1949* (Cmd. 7933), states that there are "roughly 360,000 full-time farmers" in the United Kingdom (p. 49). The context suggests that the figure relates to persons *mainly* engaged in commercial farming; it would therefore include the part-time farmers as defined in the National Farm Survey, but not the spare-time farmers. From this figure and those given above it would also appear that there are about 100,000 farmers in Scotland and Northern Ireland together. Probably about 40,000 of these were in Scotland (74).

The Occupation tables of the 1931 Population Census, besides showing the number of farmers, give sixteen other categories of persons who declared themselves to be primarily engaged in agricultural or horticultural occupations. "Farmers' Sons, Daughters or other Relatives assisting in the work of the Farm" are distinguished from "Agricultural Labourers, Farm Servants", and the latter are further subdivided into "Shepherds", "Employed in tending Cattle, Dairying, etc.", "Employed in charge of Horses" and "Not otherwise distinguished". There was also a separate category for "Agricultural Machine, Tractor—Proprietors, Foremen, Drivers, Attendants", but in 1931 these were not numerous. There would be many more to-day. All the above information is given by age, sex and locality, affording the basis for a number of studies of the composition of the agricultural population (e.g. 79, 80, 81).

The Industry Tables of the 1931 Census Reports show the numbers of males and females aged 14 years and over classified according to industry. In these tables the agricultural industry is subdivided into six groups, apart from forestry. These are farming and stock-rearing; poultry farming; market-gardening and fruit-farming; flower and seed-growing and nursery-gardening; other gardening; and other agricultural industries. The relation of the Industry Tables to the Occupation Tables (and of both to the June Returns) is discussed elsewhere (82, 2, 97-105). The most important point in interpretation concerns the treatment of persons described as gardeners or gardeners' labourers. It must also be remembered that some persons employed in the agricultural industry are not engaged in agricultural occupations, e.g., smiths, carpenters and van-drivers. The totals include persons who were out of work on the day of the Census, but not those who were retired.

The results of the Population Census are regarded as unreliable in respect of the numbers of females engaged in agriculture, particularly those of female relatives of the farmer (62, 75-76; 82, 614).

An official report published in 1938 discusses the statistics of the agricultural population in Northern Ireland (85).

Agriculture is not included in the table published monthly in the *Ministry of Labour Gazette* to show the numbers employed in various industries, but it appears as a separate category in the table showing the distribution of man-power in Great Britain given each year in the *Economic Survey*. At mid-1948 the total was given as 1,227,000. This figure is evidently based partly on

* A few of these, although they all have at least 5 acres, would no doubt describe themselves as nursery-men, seedsmen, etc.; on the other hand, the Farm Survey probably missed a few full-time farmers by excluding all holdings of under 5 acres. In numbers these two groups might have cancelled each other out.

insurance data and partly on estimates obtained from the Agricultural Departments. It represents all persons aged 15 or over who are gainfully employed in agriculture,* including employers and persons working on their own account, and persons registered as unemployed whose last employment was in agriculture.

In recent years the Ministry of Labour and National Service has published annual *Tables Relating to Employment and Unemployment in Great Britain*. These tables show the estimated total numbers of insured persons, other than employers and self-employed persons, in employment in July of the year in question, and also the registered unemployed. Males and females are shown separately, and figures are given for Great Britain and for each of the Ministry's eleven administrative Regions. The figure given for persons in employment in agriculture and horticulture in Great Britain at July, 1948 is 887,800. This includes farmers' sons and daughters and part-time workers.

Monthly unemployment figures for the agricultural and horticultural industry are given in the *Ministry of Labour Gazette* distinguishing the wholly unemployed from those temporarily stopped. From time to time the *Gazette* also publishes figures of juvenile recruitment into the industry, and some statistics of the membership of trade unions were given in the issue of November, 1949.

There are no long-established series of national statistics dealing with the incomes of farmers or the earnings (as distinct from wage-rates) of farm workers, but a beginning has recently been made in the publication of certain total amounts in the annual White Paper on the *National Income and Expenditure of the United Kingdom*. "Income from farming" is shown as an item in the composition of the national income (Cmd. 7933, p. 9), and in previous issues "farming" also appeared as a separate heading in the national wage bill (Cmd. 7649, p. 9). "Income from farming", given as £60 million in 1938 and £258 million in 1948, "consists of the income from agriculture, horticulture and direct retailing of farmers with holdings of one acre or more. It represents the reward of the manual and managerial labour of farmers and their wives and the return on their capital. Income from landownership is excluded. . . . The figures have been derived by subtracting from the value of the gross product of agriculture (reckoned after the elimination of duplication due to inter-farm sales) the various items of cost: rent of land, wages and salaries, purchases from other industries or from abroad and provision for depreciation of equipment" (Cmd. 7933, p. 49) (see also *Net Income of Agriculture* below).

Wages earned in farming, given as £212 million in 1948 and £191 million in 1947, exclude forestry.† "Wage-earners include all employees other than administrative, technical and clerical staff. . . . Prisoners-of-war employed in this country are also excluded". It will be noted that the amount does not include the reward for the manual work of farmers and their wives, as this comes under "income from farming". All workers are dealt with as paid wage-earners, and the cash value of perquisites is included as wages. The Agricultural Departments make regular inquiries into the employment and earnings of farm workers, and although the results of these inquiries are used in estimating the national agricultural wage bill, the details of average hours worked per week, average contract wage paid per week, overtime earnings, etc., have not been published. [But see (57) for Scotland.] Some information is available concerning farm workers' perquisites in Scotland (83). Some Scottish farm wages data have also been published,

* The following is the definition of "agriculture and horticulture" given in the *Standard Industrial Classification* (London: H.M. Stationery Office, 1948) and used in the national man-power statistics.

Agriculture and Horticulture

1. *Farming (not fruit) and stock-rearing*.—All types of agricultural holdings, except market gardens and holdings used mainly for the production of fruit, flowers or seeds. Ancillary activities such as ditching, thatching and the destruction of rabbits and other vermin are included.

2. *Agricultural contracting*.—Services such as ploughing, harvesting or threshing performed for farmers on a contract basis.

3. *Market gardening, fruit, flower and seed growing*.—Agricultural holdings used mainly for the production of vegetables, fruit, flowers or seeds (other than seed potatoes, which are included in "Farming and stock-rearing"). Nursery gardens producing plants, fruit trees, ornamental trees and shrubs, etc., are included.

† It appears, however, that from 1949 onwards the White Papers will give only a combined figure for agriculture, forestry and fishing. See Cmd. 7933, pp. 11, 53.

based on a sample of 199 farms whose accounts were supplied to the Department of Agriculture for each of the seven years 1939-40 to 1945-46 by the Advisory Agricultural Economists at the three Colleges (71).

Agriculture is not among the industries for which the Ministry of Labour publishes an index number of weekly wage rates. For many years, however, *minimum* rates of wages have been in operation, and index numbers based on these have appeared in various publications. [The Ministry of Labour's *Abstract of Labour Statistics*, 1937, and earlier issues; *N.F.U. Information Service*, December, 1949; *Farm Economist*, April-June, 1946, and subsequent issues; 2, 152; 87, 88, 89, 90.] A *national* minimum wage for adult male workers was first introduced in June, 1940, when the rate was fixed at 48s. per week. The figure was increased on several subsequent occasions, and on March 13th, 1949, was fixed at 94s. per week for a 47-hour week.

An index of minimum wage rates may not, of course, accurately reflect the trend of average earnings. Some workers are paid at rates above the minimum on account of special skill or responsibility. This "premium" which they receive may vary relatively to the minimum rate for ordinary workers, and so may the proportion of ordinary to "special" types. The average number of hours worked per week may change, leading to a higher or lower proportion of overtime earnings in total earnings. The length of the working week to which the minimum rates apply has been altered from time to time. Some workers are paid on a piece-work basis; their numbers may change in relation to the total, and so may the level of piece-work rates compared to that of time rates. There is no information of the net effect of all these factors but, for Scotland at least, "such evidence as there is suggests that the relative increase in earnings (between 1939/40 and 1945/46) has not differed substantially from the relative increase in wage rates" (71, 63).

Some facts about the pre-war level of agricultural wages in Northern Ireland are given in the official report already mentioned (85).

The numerous reports, both national and local in scope, which have been published as an outcome of the Farm Management Survey Scheme throw a good deal of light on farming incomes, the employment of labour and wage payments. Tables and reports dealing with conditions of profit and cost in agriculture are published at frequent intervals by the agricultural economics departments of the Universities of Bristol, Cambridge, Durham (King's College, Newcastle-upon-Tyne), Leeds, London (Wye College), Manchester, Nottingham, Reading and Wales (University College of Wales, Aberystwyth); and by the economics departments of the three Scottish Agricultural Colleges of Aberdeen, Edinburgh and Glasgow.

Agricultural economists employ a number of technical terms (e.g. farm income, investment income, labour income, family income) to describe various aspects of farming income, in order to allow for variations in the treatment of such items as the wage payable to the occupier for his own labour, interest on farm capital, unpaid family labour, rental value of house, private drawings in kind, etc. (130, 6). The usual method of presenting the financial results for a group of farms in a given year is to show the average gross receipts per farm, analysed by products, and the average gross expenses per farm, analysed according to the nature of the service paid for; then to show the average net change (plus or minus) in the value of farm stocks on hand at the beginning and end of the financial year; and hence to arrive at a figure of average "farm income" (realized and unrealized) for the year.

In presenting figures of employment and wage payments the economists draw attention to changes in the annual wage bill per farm and per acre on farms of different sizes and types.

Consideration of the amount of labour employed per farm sometimes involves the conversion of the various types of worker to their full-time man-equivalents in accordance with a fixed scale of conversion rates. There is little statistical evidence on which to base these rates, but the following have been used unofficially in connection with the Agricultural Returns of labour employed.

	Units
<i>Regular Workers:</i>	
Males, 21 years old and over	1.00
Males, under 21	0.75
Women and girls	0.60

Casual Workers;

Males, 21 years old and over	0·75
Males, under 21	0·60
Women and girls	0·50

Members of Women's Land Army 0·66

Prisoners-of-War 0·50

For some calculations it is necessary to add an allowance for the labour of occupiers and their wives. See also (56, *III-III4*). The relationships most commonly studied are man-equivalents per farm and per 100 acres (adjusted for rough grazings); labour cost per farm and per 100 acres; and gross current production (£) per man-equivalent and per £100 labour cost.

A valuable source of statistical data on farm profits, wages and costs is the National Farmers' Union Farm Accounts Scheme. Under this Scheme, which was started in 1944, analyses are prepared each year on the basis of information provided in a standardized form by accountants on behalf of their farmer clients. The published results show, by size and type of farm, the average revenue, expenditure and profit per farm, profit per acre and per £100 rent, change since the previous year in the average profit per farm over a number of identical farms (i.e. all the farms providing information in both years), the percentage distribution of receipts and expenses over the various items, and the net output per farm and per £100 wages. A convenient summary of the results to date was given in the *N.F.U. Information Service* for Sept., 1950. Wages were analysed in respect of regular, family and casual labour in the issue of October, 1949. A further useful set of summary tables, with commentary, was prepared from N.F.U. material by the *Economist Intelligence Unit* and included in a factual compilation called *The Rural Market* (86).

Statistics of bankruptcy among "farmers and graziers" were published in the Annual Report on Bankruptcy until publication was suspended in 1939. The Report is expected to resume publication shortly. Between 1941 and 1948 the annual average number of bankruptcies occurring among farmers and graziers in England and Wales was only 21. See also (91, 92).

Machinery

No comprehensive national inventory of farm machinery and implements was taken until 1942. Some statistics are, however, available for certain dates before this. In 1908, 1913, 1925 and 1931 (1, 2, 3, 4, 5, 6) inquiries took the form of supplementary questions to the annual Agricultural Returns. Replies were voluntary, and fell short of a complete enumeration of the machinery returnable by some 20 or 30 per cent. (2, 108 and 5, 44). The main concern before 1942 was with power machinery (fixed or portable), though in the Scottish returns of 1925 and 1931 certain kinds of barn machinery were also enumerated, while in Northern Ireland the 1925 census listed a wide range of implements as well as power machinery. Motor tractors were first returned throughout the United Kingdom in 1925, those for field and stationary work being shown separately.

The published results of these pre-1942 censuses included tables showing the distribution of machinery according to geographical location (by agricultural divisions), acreage of holding and horse power. County figures were not published.

A census of tractors on agricultural holdings was taken in Great Britain in September, 1937, and again in June, 1939. Returns were still voluntary, but the 1939 enumeration was thought to have been virtually complete. Both the 1937 and the 1939 numbers were published for each county in England and Wales, distinguishing wheel tractors for field work, wheel tractors for stationary work, and tracklaying tractors (7, 8). National totals have been published for Scotland (9, 10). On various occasions between March, 1940, and March, 1942, the quarterly agricultural returns included questions relating to tractors and other major items of farm machinery, but no statistics have been published.

In May, 1942,* occupiers of agricultural holdings in Great Britain were compulsorily required to make a return of machinery owned by them, "to find out how much machinery is now avail-

* June in Scotland.

able . . . and what is the minimum quantity that must be provided for replacements or to meet the needs of the increased acreage of arable crops." Returns were also obtained from contractors (who, unless they were occupiers of agricultural holdings, had not been covered by previous inquiries) and from County War Agricultural Executive Committees, who had by this time established machinery pools.

In the schedule seventy-six different kinds of machine were listed.* Only serviceable machines were to be counted. Horse-drawn and tractor-drawn implements were shown separately. Ploughs were further classified according to the number of furrows.

Since 1942 machinery returns have been required in much the same detail at intervals of approximately two years. National totals have been published for each census, and separate figures have been given for machinery owned by County War Agricultural Executive Committees and by the Department of Agriculture for Scotland (11, 12, 13). County figures for tractors and selected items of machinery have been published for 1942 and 1944 (14, 15).

The official statistical publications contain no analyses since 1931 of the numbers of tractors or other machines in relation to acreage of holding, type of enterprise or any other farming characteristic. Figures have, however, been published elsewhere showing the distribution of many types of machine by size of holding in England and Wales in 1946, and in five selected counties in 1939 (tractors only), 1942 and 1946 (16). The distribution of tractors in Scotland in 1946 has been briefly described (78). Tables have also been published, in connection with the National Farmers' Union Farm Accounts Scheme, to show the numbers of tractors, combine harvesters, crop driers and milking machines possessed by a sample of nearly four thousand farms, and their distribution by acreage of holding and type of enterprise (17, 18, 19). The 1936/37 report of the Farm Management Survey shows the average inventory value of machinery per £100 rent, per £100 gross current production and per man equivalent, for each of 60 farming areas (27). The 1938 report adds figures per farm and per 100 acres (28). These sources, in conjunction with the official statistics, provide material for a study of the course and extent of mechanization in different parts of British agriculture.

Some attempts have been made to express the total available draft power (tractors and horses) in terms of the equivalent number of working horses. Such calculations are usually concerned with the effective replacement rate of tractors for horses, and not with their relative mechanical horse-power. (An exception is 152.) The appropriate conversion factor to be used for the average tractor has not yet been firmly established, but four horses to one tractor is the ratio which appears to have gained acceptance recently (20, 21, 22). International comparisons have been made with regard to the percentage of total agricultural draft power which is provided by tractors (20). The United Kingdom is well ahead of all other European countries in this respect.

Statistics of the numbers of various types of agricultural machinery produced in the United Kingdom are published monthly (23), and annual figures are available since 1937 (24). The total value of the machinery produced and the value of machinery destined for export are also given since 1946 (23). Some earlier figures are given in the Census of Production reports. The monthly Trade and Navigation Accounts and the annual Statements of Trade give statistics of imports and exports, by country and by weight and value, of a number of categories of agricultural machinery. Dairy machinery and tractors appear separately from the main group. The statistics of production, imports, exports and total supplies to the home market, down to mid-1948, are presented in a very convenient form in a report on the agricultural machinery industry published by P.E.P. (Political and Economic Planning) in 1949 (21).

No official statistics of machinery prices are available. It has been estimated unofficially that in mid-1946 prices were some 56 per cent. higher than in 1936-38 (25). The P.E.P. report contains a table showing export values (£ per ton) of certain British agricultural engineering products for a number of years between 1920 and 1948 inclusive, and also quotes estimates made by the Ministry of Agriculture and Fisheries which suggest that prices rose by about 70 per cent. between October, 1939 and January, 1948. A table is appended to the P.E.P. report which gives estimates of tractor requirements, production, imports and exports in the main manufacturing

* In Northern Ireland the statistics arising from the 1942 inquiry are confined to tractors, ploughs, disc harrows, binders and portable threshers. In 1944, however, a full inventory was made (11), and this was repeated in 1945. Since 1947 there has been an annual inquiry of limited scope. No statistics have yet been published for the years since 1944.

and importing countries in 1950–51 (21, Appendix XIII). Prices and specifications of tractors currently obtainable are conveniently collated in the *Farmer and Stock-breeder Yearbook*.

Electricity and Water Supplies on Farms

The National Farm Survey of England and Wales (1941–1943) collected information on the use of electricity on farms of 5 acres and above, distinguishing public from private supplies and household from farm use. At that time about 78,000 holdings were supplied with electricity. County figures are available in the *Report*, which also shows, for England and Wales as a whole, the relationship between size of holding and proportion of holdings supplied, and the proportion of holdings using electricity for various purposes. Another table shows the relationship between supply of electricity and number of cows on the holding. Only 7 per cent. of holdings having 1 to 10 cows were supplied with electricity to farm buildings, and even in the case of holdings having 100 cows or more, only 64 per cent. were so supplied.

The *National Farm Survey Report* also contains statistics of the water supply to farm houses, farm buildings, and fields, analysed by source of supply and size of holding.

In Scotland the Agricultural Returns of March, 1943, included questions on electricity supplies, and another census was taken in September, 1948. No account of the results has yet been published.

Some figures obtained through the N.F.U. Farm Accounts Scheme and dealing with electricity and power supplies on farms in 1946–47 were published in the *N.F.U. Information Service*, December and October, 1950.

Tenant's Capital

Official estimates of the average amount of tenant's capital per acre were made by the Crop Reporters in England and Wales in 1925 and 1931 (2, 5). The figures were analysed according to size of holding, type of holding (arable, pasture or mixed), and geographical division. The general average was £13½ per acre in 1925 and £10½ per acre in 1931. This includes the value of live and dead stock at current rates, the tenant right valuation and cash in hand to meet farm outgoings.

No national estimates have been published since 1931, but the reports of the Farm Management Survey give the average value of capital held in the form of livestock, crops and machinery per 100 acres and per farm in many different farming areas of England and Wales (27 to 32). Judging from these reports, typical figures would be £11 per acre in 1937, increasing to £14 or £15 per acre in 1943. Later figures of comparable scope have not yet been published, but a number of provincial reports are available which include data of this kind.* Similar figures have appeared for Scotland (33 to 44) and for Northern Ireland (45, June, 1949 issue).

Agricultural Credit

Statistics of advances made by joint stock banks to farmers are available through the quarterly analysis of bank advances prepared by the British Bankers' Association. Some recent figures and a note on their interpretation will be found in the *N.F.U. Information Service*, March, 1950, p. 64. For advances made in Scotland between 1939 and 1948, see (10, 40). Credit is also made available through the Agricultural Mortgage Corporation, the Lands Improvement Company, and the Scottish Agricultural Securities Corporation, and statistics are given in the annual reports of these bodies (see, for example, *The Times*, May 30th, 1949).

Crop Acreages

The June Returns are the main source of crop acreage statistics. Occupiers are required to state the acreage under each of the specified crops on the date of the Return to the nearest ¼ acre. Land under preparation on that date (apart from bare fallow) is returnable as being under the crop for which the land is being prepared. Provision is made for the return of areas under crops not specified on the schedule, but woodlands, buildings, roads, yards, ponds, quarries, etc., are not returnable, so that strictly speaking the total area of crops, grass and rough grazings is

* See also *N.F.U. Information Service*, July, 1950, p. 139; and *Reports from Committee of Public Accounts, Session 1948–9*, p. 437.

1951]

not identical with the total farm area. Headlands, hedges and ditches are, however, attributable to the crop grown in the field in question. It is unlikely that these niceties are observed by the majority of farmers.

On the whole, continuity in the number and description of the specified crops has been well preserved over the past eighty years.* Such changes as have occurred have been mainly in the direction of more detailed information, particularly with regard to vegetable crops. For example, the general heading "peas" has been replaced by four descriptions, viz. "peas for stockfeeding", "green peas for market", "green peas for canning" and "peas harvested dry" (for human consumption). Since 1922, cabbage, etc., grown for human consumption has been returned separately from that grown for stockfeeding. A detailed account of the vegetable statistics for England and Wales will be found in a paper by W. F. Darke (96). In 1949 no fewer than 31 descriptions appeared in the June Returns under the general heading "Vegetables for human consumption, crops under glass and flowers", but only about 15 per cent. of occupiers have anything to return in this section, and for most of them the total area under vegetables is less than 3 acres.† It is clear that in such cases individual entries to the nearest $\frac{1}{4}$ acre will be liable to a considerable margin of error.

In the annual Return occupiers are not required to differentiate between the various kinds of orchard fruit, but six kinds of small fruit are mentioned. A special Fruit Census was taken in 1944, and this provided statistics not only of the numbers of trees of different varieties, but also of their age and density of planting (95, 316).

It is realized that the June Return is not suitable as a means of collecting reliable statistics of the area of crops grown under glass, and in recent years growers of these crops in England and Wales have been required to complete special glasshouse returns in January and July. Areas are expressed in square feet. (*N.F.U. Information Service*, December, 1948, 204, and December, 1949, 216.)

Although June is the most opportune month for a general return of crop acreages, occupiers are asked in December to state their acreages of autumn-sown wheat and rye, and this first indication of crop possibilities for the coming year is followed by a return in March of the acreages which occupiers expect to have under certain important crops in June of the same year. A comparison of these forecasts with the June acreages is provided by the following table :

Crop Acreages in Great Britain

	March 4th, 1949 (Forecast)	June 4th, 1949	March 4th, 1948 (Forecast)	June 4th, 1948
	(Thousand acres)			
Wheat	1,986	1,962	2,314	2,275
Barley	1,988	2,053	1,979	2,077
Oats	2,847	2,877	2,893	2,945
Mixed Corn	692	673	626	591
Rye	67	69	63	66
Potatoes	1,110	1,122	1,269	1,338
Sugar Beet	416	420	410	413
Turnips, Swedes and Mangolds	1,030	905	1,035	931

The harvesting and marketing of vegetables continues in one form or another all the year round, and to supplement the information obtained in June the Agricultural Returns of March, September and December require a statement of the acreages under specified vegetable crops at the date of the Return. The Ministry of Agriculture also obtains monthly estimates, through its own field staff, of the acreages cleared by a given date and the acreages expected to be marketed during a given period.

* Acreage tables for the years 1866-1932 will be found in (48, Appendix). For Wales only, 1867-1939, see (62, Appendix 8).

† Potatoes are not included under vegetables in U.K. statistics.

It is difficult to form an opinion on the accuracy of the parish, county and national figures of individual crop acreages. In the case of crops on which an acreage payment has been made (as a subsidy additional to the market price per ton), it has been found that the total acreage shown in the June Returns usually agrees within 1 or 2 per cent. with the total given by the acreage payment certificates. These are issued only after counter-signature of the farmers' claim by an official of the County Agricultural Executive Committee, and field inspections of the acreages thus certified take place to the extent of about a quarter of the total acreage. In the case of sugar beet, the June Returns agree closely with the acreage contracted by the British Sugar Corporation, after allowance is made for crops grown for seed.*

It is probable that more inaccuracies occur in the returns of temporary grass and permanent grass than in those of tillage crops. This is partly on account of the practical difficulty of applying the official definitions—which call for a distinction between grass which is "in the rotation" and that which is not, and a further distinction between "rough land used for grazing" and other permanent grass—and partly because the occupier, having in mind a figure which he supposes to represent his total acreage, enters his arable crops and then writes down the balance as permanent grass without further verification.

The routine programme of statistical tabulation does not provide information about the number of occupiers who grow certain crops, but some figures of this kind are available. In 1948 there were approximately 102,000 growers of wheat in England and Wales; 23,000 of these grew not more than 5 acres each, while over 2,000 grew at least 100 acres each. The average wheat acreage per grower was 21 acres. In the same year there were 4,300 growers of rye (not for green fodder), and the average was 13 acres per grower. About 170,000 occupiers of agricultural holdings in England and Wales grew potatoes. 40 per cent. of these grew less than 2 acres each but these accounted for only 7 per cent. of the total acreage grown. Over 700 growers grew at least 100 acres of potatoes each, and these together accounted for 13 per cent. of the total acreage (excluding potatoes grown in gardens, allotments, etc.). These figures are based upon acreage payment claims tabulated by the Ministry of Food. Statistics prepared by the British Sugar Corporation show that there were 41,000 growers of sugar beet in Great Britain in 1949. The average was 9.8 acres per grower. 182 growers grew over 100 acres each. An interesting example of what can be done in this form of analysis is shown in tables appended to a recent report on apple marketing in England and Wales† (97, 49). They state, for certain counties, how many June Returns in 1946 recorded some acreage of apples, the average acreage recorded and the distribution of holdings according to acreage of apples. There are indications that further analyses of this kind may be expected in due course. The members of the Interdepartmental Committee on Social and Economic Research expressed their general agreement with the proposal put forward by the Ministry of Agriculture and Fisheries "that the annual tabulation scheme should comprise, in roughly equal parts, a selection from routine analyses of agricultural census data and special tables based on material derived from other sources or suggested by significant trends observed in the course of routine analyses" (98, 6).

A few statistics of acreages under specified *varieties* of crops have been published. The Ministry of Food analyses potato acreages into 42 separate varieties (N.F.U. Information Service, March, 1950), and from 1934 to 1938 figures were given in annual publications of the Potato Marketing Board (65). In Northern Ireland statistics are prepared showing how much of the acreage under potatoes is planted with varieties immune to certain diseases. The National Institute of Agricultural Botany, Cambridge, has prepared a table showing the relative acreages of different varieties of wheat, but the figures relate only to samples sent to the Institute for testing (53, 391).

The geographical distribution of crops has been depicted from time to time in maps on which the density of occurrence of a crop is shown by depth of shading or frequency of dots (99, 100, 53, 102-105, 2, Ch. III, 48, 11 and 395).

The distribution of corn crops, potatoes, roots, rotation grasses and other crops *by size and type of holding* is available for England and Wales for the years 1924 and 1930 (2, Ch. VII, and

* All the crop acreages given by the June Returns include crops grown for seed.

† Other countries have carried out similar analyses. For example, in Holland figures were published in 1937 to show the number of farmers who grew wheat, barley, oats, potatoes, sugar beet, etc., and the number who kept cows, pigs, horses, sheep, hens and ducks.

Agricultural Statistics, 1932), and a table in the *National Farm Survey Report* shows what proportion of the cultivated area in different types of farming is devoted to cereals, potatoes and sugar beet, fodder crops, etc. (52, 86). Tables of a similar kind have been published for Scotland (3, 66 and 6, 53) and for Northern Ireland (4, 54-63), but there appears to be no tabulation relating to any recent date.

Livestock Numbers

Cattle, sheep and pigs on agricultural holdings in Great Britain have been enumerated annually in the June Agricultural Returns since 1867, and horses since 1870. Poultry were included in 1908, 1913, 1921 and 1924, but regular collection of poultry numbers did not begin until 1926. Goats have been enumerated on a number of occasions, the most recent being December, 1949. Winter censuses embracing cattle, sheep and pigs were made annually from 1935 to 1938, and quarterly returns have been made since December, 1939. These also cover poultry. With certain exceptions, statistics of livestock in Northern Ireland have been prepared at the same intervals.

In the cattle statistics of Scotland "dairy cattle" are distinguished from "beef cattle". No such distinction is made in England and Wales or Northern Ireland, although attempts were made to establish it in England and Wales in December, 1936, and December, 1937 (*Agricultural Market Report*, February 5th, 1937). The main difficulty is that so many farmers keep cattle of dual purpose breeds. The statistics distinguish "cows and heifers in milk" and "cows in calf but not in milk" from other cattle, but to describe these as "dairy cows" is a misnomer, since in some cases none of their milk is used for human consumption or manufacture.

There are no comprehensive statistics of the numbers of cattle of different breeds, but it is possible to trace certain changes in their relative importance by studying the annual figures of the numbers of bulls licensed by the Agricultural Departments (*N.F.U. Information Service*, January, 1949, p. 17; and 10, 103). The main tendency is a great increase in specialized dairy breeds.

The Milk Marketing Board compiles a wide range of statistics dealing with the numbers and sizes of milk-selling herds in England and Wales, average length of life of cows, extent of artificial insemination, etc. These statistics appear in the Board's occasional publication, *Milk Facts and Figures*, and in the annual reports of the Board's Bureau of Records.

The National Farm Survey Report contains a table showing the distribution of holdings according to the number of cows kept, for each type of farming in England and Wales (52, 17).

A very close study of the cattle statistics of Great Britain was made by Miss J. G. Marley and presented in a paper read to this Society in 1947 (101). Further details, therefore, will not be given here. In using the statistics it should be kept in mind that future changes in meat supplies cannot readily be predicted from the statistics of cattle population, owing to the possibility of changes in the average age at slaughter and associated changes in rate of turnover, carcase weight per beast, fluctuations in the imports of store cattle from Eire, and other factors.

A break in the series of statistics of sheep numbers occurred in 1938, when two-tooth ewes (shearling ewes or gimmers) were returned separately from other ewes kept for breeding. Previously many of the two-tooth ewes would seem to have been counted in the category "other sheep over 1 year", and not as "ewes kept for breeding".

Sheep of hill breeds are not distinguished from others, but certain statistics have been produced as a result of the operation of the Hill Sheep Subsidy, introduced in 1940-41. These statistics are summarized and interpreted in a paper given by D. H. Dinsdale to the Agricultural Economics Society in 1949 (102). For a discussion of sheep numbers and breeds in Wales, see (62, 37-40 and 184). Sheep in Scotland were classified by breed in 1931 (6, 71).

Pig population statistics have been discussed in a series of articles in the *Pig Breeders' Gazette*. Apart from sows and boars, pigs are returnable in three age-groups, "5 months old and over", "2 months old but not yet 5 months old", and "under 2 months old". Study of the quarterly figures suggests that these groupings are not very accurately observed by farmers. In using statistics of pig numbers it must be remembered that there is a considerable non-farm population.

This last remark is even more applicable in the case of poultry. There were 16 million adult fowls in the United Kingdom in 1946 which were not kept on agricultural holdings (133, 51). In 1948 four out of five agricultural holdings in England and Wales carried a number of adult

fowls, but two-thirds of the flocks contained less than 50 birds, and less than 3,000 holdings carried a flock of over 500. In 1939 there were nearly 5,000 such flocks (103).

The figures for horses distinguish between "horses used for agricultural purposes" and the rest. There was a break in the series in 1911 owing to a change in the definition of the category "other horses". There is also a curious irregularity in the statistics for England and Wales in 1942 which has never been explained. It appears that in that year some 50,000–60,000 horses which in other years would have been returned as "used for agricultural purposes" were entered under the heading "all other horses". In the following year the series resumed its former trend. It is very unlikely that in 1942 any such redistribution really took place.

Little is known about the number of horses which are kept elsewhere than on agricultural holdings of over 1 acre, but some indication may be obtained from the results of a census taken in 1934 on behalf of the War Office (104).

As in the case of crops, maps have been prepared on various occasions to indicate the geographical distribution of different kinds of livestock (2, Ch. IV; 99, 100, 53, 106–7).

Similarly, there are tables to show the distribution of livestock by size and type of holding (2, Ch. VII; *Agricultural Statistics*, 1932; 52, 86; 3 and 6, Appendix Tables; 4, 57–63; 1, Appendix Tables).

It is sometimes desirable to consider all forms of livestock in aggregate, and for this purpose "livestock units" are used in a similar manner to "man-equivalents" discussed above. A number of sets of conversion rates have been put forward for application to British agriculture. The variation between them is partly due to the different purposes which the authors have had in mind. For example, the relative importance of the various kinds of livestock would not be the same in regard to labour requirements as in regard to feed requirements. The following weighting factors, representing total energy requirements in terms of starch equivalents, were based on Woodman's feeding standards and were used in (54):

Cows	.	.	.	.	.	7.0
Other cattle	.	.	.	.	.	5.5
Sheep	.	.	.	.	.	1.0
Pigs	.	.	.	.	.	2.5
Poultry	.	.	.	.	.	0.05
Agricultural horses	.	.	.	.	.	9.5

The following weights "are believed to be reasonably representative of average Scottish conditions" (93, 59):

Dairy cows	.	.	.	.	.	9.0
Other dairy cattle	.	.	.	.	.	4.5
Beef cows	.	.	.	.	.	9.0
Other beef cattle	.	.	.	.	.	6.9
Ewes	.	.	.	.	.	1.0
Other sheep	.	.	.	.	.	0.6
Pigs	.	.	.	.	.	1.0
Poultry	.	.	.	.	.	0.13

See also (53, 36 n.).

Yields per Acre

Statistics of the average yield per acre of each of the major crops have been prepared annually since 1884. They relate to the acreages declared in the Agricultural Returns of June in the year in question. Farmers are not at present required to make returns of crop yields. The national estimates are based on reports sent in by Crop Reporters scattered all over the country, each Reporter being responsible for about 40 parishes.* A month or two before the particular crop is

* In 1949 the duties formerly carried out in England and Wales by the Ministry of Agriculture's part-time Crop Reporters were taken over by the whole-time District Officers of the National Agricultural Advisory Service. Horticultural crop intelligence is on a separate footing, and special arrangements are made for estimating the yield of hops, the cultivation of which is confined to about one thousand growers concentrated in a few localities.

due to be harvested the Reporters make forecasts of the average yield per acre in their respective districts. These forecasts are based on inspection of growing crops and consultation with growers, and at this stage it is assumed that normal weather conditions will prevail at harvest time. National yields per acre are calculated provisionally by weighting the Reporters' district estimates by the latest available district acreage figures for that crop. It is customary for these provisional yields to be published in the official Monthly Agricultural Reports. These reports are usually released to the press in the second week of each month. Thus the first official indication of the probable yield of hay crops is given on or about June 10th in the form of a verbal statement such as "rather below average", and a month later forecasts in terms of cwt. per acre are given, together with the average yield in the previous ten years. These forecasts are revised in succeeding months, and yields of cereals and root crops are added in due season. General comments are also given on the progress and conditions of harvesting and on the quality of the crops.

The final estimates of yields of grain, pulse, root and hay crops are collected on a parish basis. The Reporters are instructed to base their estimates on information obtained from representative farmers in each parish and from threshing machine proprietors, as well as on their own judgment. The average yield is intended to represent good, bad and indifferent crops in their right proportions. Production estimates for each parish are obtained by multiplying the yield per acre by the acreage under the crop in question, as given by the June Returns.* Parish production estimates are added to obtain county and national production, and hence county and national yields per acre are calculated.

At times the official crop yield estimates have been criticized, it being alleged that they are generally too low, and that their sluggish rate of increase does not give due credit for the improvements which farmers have effected. A long and lively controversy on this issue took place in 1926-27 between J. A. Venn, who contended that the official yields exhibited stagnation, fell consistently below an alternative series (*viz.* *The Times* estimates) compiled by similar methods by more numerous local observers, denied adequate expression to the occasional appearance of really good seasons, and had other weaknesses which he named, and H. D. Vigor, who took up the defence of the official system of estimating, point by point (105, 106, 107). The issue was not settled; the methods of crop-estimating continued unchanged; *The Times* yields still tend to exceed the official estimates by an appreciable margin (*cf.* *The Times*, October 10th, 1949, and *The Farmer and Stockbreeder*, October 18th, 1949).

In recent years it has been possible in some measure to check the accuracy of the yield estimates for certain crops by means of the additional marketing and utilization statistics which became available as a result of war-time controls (see below, *Utilization of Agricultural Products*, and *Agricultural Statistics, United Kingdom, 1939/40 to 1945/46, Part II*, pp. 14 and 42-3). However, because of the considerable element of farm use (which is not at present covered by the disposal information), the check can only be very rough, and perhaps the most that can be said is that if there is any bias in the official yield estimates it does not appear to be such as to give rise to production estimates which are irreconcilable with the other statistics available.

The official statistics do not include a composite crop yield index to indicate the trend in physical productivity per acre, but some unofficial figures have been published 108 (for Great Britain figures) and 109 (for England and Wales figures). The true position regarding the productivity of agricultural land as a whole (arable and grass) is very difficult to determine on account of the statistical problems involved in measuring the yield of pasture land. Calculations of the numbers of livestock carried or of the output of livestock products per acre are not entirely satisfactory because they are affected by the feed conversion efficiency of the stock grazed. (See also below, *Current Estimates of Agricultural Output and Feedingstuffs Supplies*).

Yields Per Head and Gross Livestock Production

Until quite recently, despite the traditional importance of livestock products in the output of British agriculture, relatively little attention on a nation-wide scale was given to the collection of

* It is customary to confine the word "yield" to expressions of quantity produced *per acre* (or *per head* of livestock), and to use "production" to signify total quantities. Thus in 1939 the production of wheat in the United Kingdom was 3,138,000 tons, and the yield, 19.5 cwt. per acre. In this terminology, therefore, higher yields do not necessarily result in higher production.

data dealing with the yield of milk per cow, meat per beast slaughtered, eggs per bird, or wool per sheep shorn. It will be appreciated that statements of this character from farmers would require more painstaking records than does a simple account of acreages and livestock numbers. Consequently there are no continuous annual series comparable to those of crop yields per acre.

In the Agricultural Output inquiries of 1908, 1925 and 1931 occupiers were asked to state the total quantity of milk produced, the number of eggs produced and the quantity of wool clipped in a given period of twelve months, and from the incomplete figures obtained—the replies were entirely voluntary—tentative calculations of average yields were made. There was an unknown element of bias due to the unrepresentative character of the occupiers who supplied information. Furthermore, there was no means of determining to what extent the years in question were normal or exceptional in the levels of yield attained. For the years between the censuses of output there was no information. In the case of meat production, numbers slaughtered in the census years were calculated on the basis of (i) occupiers' statements of births and deaths of livestock on farms, (ii) changes in total numbers between successive annual June Returns, and (iii) imports of store animals during the period. The average dressed carcase weights per animal slaughtered were based on special inquiries made of butchers and owners of slaughter-houses in different parts of the country.

In the 1930's some improvement took place in the statistics of average milk yields, following the establishment of the Milk Marketing Boards. From 1934 the Boards' transactions accounted for a larger and larger proportion of total milk production, and by 1939 they were dealing with over two-thirds. The remainder was mostly fed to livestock, manufactured on farms into butter or consumed in farm households. A special inquiry in 1936 provided information on the order of magnitude of these items. For the average of the years 1936/37 to 1938/39 the total figure of milk produced in the United Kingdom was estimated to be 1,781 million gallons. This gives an average yield per cow ("cows and heifers in milk" and "cows in calf but not in milk") of 542 gallons per annum. The average fell to 459 gallons in 1941/42, but thereafter it recovered, and by 1948/49 had reached nearly 570 gallons.

These average yields, it should be emphasized, are based on sales and farm utilization, not on daily recording of the yields of individual cows. Such recording, however, is practised on a fairly wide scale. Prior to 1943 it was confined largely to a small circle of pedigree breeders, but in that year the Milk Marketing Board agreed to organize milk recording in England and Wales on a national basis. By March, 1948, almost one-fifth of all cows were recorded (*Milk Facts and Figures*, No. 4, revised September, 1948). In 1946/47 the average yield in recorded herds was 682 gallons (7,040 lb.) per lactation, which was well above the 509 gallons estimated as the average annual yield for all cows in the United Kingdom. The two series of yield estimates relate to different "populations", and they should be kept quite distinct.

The Egg and Poultry Census of 1937 produced evidence on which to base national estimates of egg yields per bird, and it has not yet been possible to move away from that basis, as marketing statistics have not become sufficiently comprehensive. Year-to-year changes in average yields are at present estimated from evidence which is largely non-statistical in character. There is room for much improvement here, especially as eggs contributed 8 per cent. of the value of agricultural output before the war and might contribute still more in the future.

No information on the yield of clip wool per sheep shorn has been published since the results of the 1931 Census inquiries were given, and although since 1940/41 "reliable figures of the total clip and its value were supplied direct from the Bradford Wool Control", there is no estimate of the number of sheep shorn to which these production figures could be related.

The trend in the average dressed carcase weights of cattle, calves, sheep and lambs and pigs since 1939 may be deduced from published tables of meat production and number slaughtered. These were drawn up from the Ministry of Food's comprehensive records of animals passing through collecting centres, so that the use of average weights based on figures supplied by butchers, etc., is no longer necessary. Beef carcasses, which averaged 591 lb. in 1939/40, fell to 553 lb. in 1941/42, but rose again to 580 lb. in 1945/46. The average for sheep and lambs increased slightly in this period, from 44 lb. to 46 lb. per carcase. Both pork and bacon pigs were killed at considerably heavier weights in 1945/46 than pre-war.

Market Prices

The price-reporting service of the Ministry of Agriculture deals with a wider range of British agricultural products and requisites than any other in the United Kingdom, but there are also a number of commercial agencies each dealing in detail with a restricted range of commodities. Of these perhaps the best known is that of Broomhall on the corn trade. Many price statistics are made to serve two purposes, to provide a basis for farmers' day-to-day business decisions and as an historical record of the economic state of the agricultural industry, but all are not equally satisfactory in this dual role.

Pre-war the Ministry of Agriculture drew information on agricultural prices from part-time reporters appointed for specified commodities at selected markets. For these commodities they were required to submit weekly reports showing the average prices realized for specified classes or grades together with an appraisal of the state of trade in general. Prices of fat, store and breeding livestock, cereals, feedingstuffs, fertilizers, fruit and vegetables, hay and straw, live poultry and provisions were collected in this way.

The prices quoted refer, in the main, to wholesale dealings, i.e., transactions between, on the one hand, a wholesaler, and on the other, a retailer buying for resale to consumers. In markets where the bulk of the trade in provisions was between producers and consumers, prices were quoted accordingly. There were two clearly defined types of potato markets, viz. growers' markets concerned with grower-wholesaler transactions, and wholesale markets concerned with wholesaler to wholesaler or wholesaler to retailer trade. Two series of price reports were therefore obtained.

These price quotations together with brief comments on the state of trade at the various markets were regularly published pre-war by the Ministry of Agriculture in the weekly "Agricultural Market Report". Material in this form, of interest rather to the farmers in their business than to economists and others concerned with broader aspects of agriculture, is available in these Reports back to the beginning of the century. The series of prices for home-grown wheat, barley and oats are unique in extending still further back, well over 100 years, the earlier records being available in the Statistical Abstract of the United Kingdom.

Similar data relating to Scotland but in summarized form were published in the annual volumes of *Agricultural Statistics* for Scotland.

This system of reporting continues for those commodities for which fixed prices are not guaranteed under the Agriculture Act, 1947. The Market Report is no longer published in its pre-war form, but a brief report on prices of cereals, potatoes, certain fruits and vegetables, dairy cattle and store stock is still prepared monthly. Under the Agriculture Act, 1947, prices are guaranteed in advance for products representing over four-fifths of the value of agricultural output; fruit and vegetables are the main products excluded. For these commodities information on prices is no longer derived from a reporting service. Instead it is drawn from the schedules on which are set out, for the information of farmers, merchants, etc., the details of the guaranteed prices for each grade of produce at each season of the year. Livestock producers are guaranteed minimum prices two to four years ahead (reviewed biennially), and know the actual prices for the year at least a month or two before it starts. Crop producers know the prices they will receive some 18 months ahead of harvest in comfortable time to plan their sowing programme. The actual average prices both to the individual farmer and for the country as a whole naturally depend on the proportion of the various qualities, grades, etc., in the output.

Fixed price schedules also provide all the information producers are likely to need on prices of feedingstuffs and fertilizers. Rearers of store livestock and producers of other products, of which fruit and vegetables are the most important, which do not come within the guaranteed price system, however, no longer have the kind of information the Market Reports gave pre-war. Reports in the agricultural press provide certain information, but many such reports are generally acknowledged to be an unreliable basis for forming business decisions.

To an increasing extent during the 1930's the significance of market prices as *direct* indicators of the farmers' situation declined. For example, milk producers were paid a "pool" price calculated by the Milk Marketing Board on the basis of the overall return from manufacturing and liquid markets. Wheat producers received, in addition to their returns in the open market, a flat rate subsidy calculated by reference to the country-wide average of these market prices.

producers participating in the Pigs Marketing Schemes received a price for their pigs based on the cost of a standard feedingstuff ration. Statistics relating to these supplementary elements in commodity prices were also noted in the Agricultural Market Report, together with various other statistics obtained as a result of the workings of commodity marketing schemes, such as the average prices realized by various classes of cattle.

Index Prices

The detailed weekly statistics presented in the Market Reports also formed the basis for a section of price statistics designed rather for the student of the broader aspects of agriculture than for the farmer in his day-to-day business. They were summarized to give monthly and annual average prices for the more important commodities, which in turn were used to prepare probably the most interesting of the summary series—monthly and annual index numbers of prices of individual products, groups of products (e.g., "livestock", "crops"), and finally agricultural products as a whole. These indices were also published regularly in the Market Reports, but are most readily available for reference for pre-war years in the *Annual Agricultural Statistics* volumes published by the Ministry of Agriculture and Fisheries (England and Wales). A summary of the annual index prices and price indices 1906–24 was published in *Agricultural Statistics*, 1924, Part III. Thereafter current statistics were reproduced annually in Part II of the annual *Agricultural Statistics* until 1935, and from 1936 to 1939 in Part I. Similar series relating to Northern Ireland were published in the *Monthly Report of the Department of Agriculture for Northern Ireland*. Material for the earlier years of the war period was contained in *England and Wales Agricultural Statistics*, 1940–44, Part II, and in the corresponding volume for Scotland (26). For these years the prices quoted for fat livestock and provisions are based on the price schedules in force under the Regulations operated by the Ministry of Food. Since these often use different categories and definitions from those on which reporters made their pre-war returns, direct detailed comparisons between war-time and pre-war prices are virtually impossible. Prices averaged over all grades of a product are not affected by these changes in detailed classification, so the index prices and price indices for the major products also contained in this volume are comparable with those published pre-war.

Price Index Numbers

The method of calculation of the price index numbers is of special concern to their interpretation during periods, such as the last decade, when the whole pattern of the industry, as well as the grade composition of sales of individual products, has changed. The fullest available description of the method now used was given by Mr. Houghton to this Society in 1938 (111), and a briefer official statement was published in the same year (112).

The Ministry of Agriculture has published series of index numbers for products sold by the farmer, and for the fertilizers and feedingstuffs he buys, extending back to 1906. They are intended to indicate the net effect on farmers' receipts of the various changes in the prices of a variety of commodities of greatly differing importance in agricultural output. The series from 1906 was first published in 1913, using as base the average of 1906–08 calendar years = 100. The index number for each agricultural product was based on market reporters' quotations for second quality produce. In the construction of the *general* index these were weighted by the value of the output of the corresponding product as estimated in the Census of Agricultural Output, 1908. The base period was changed to 1911–13 soon after the end of World War I, but otherwise the system of calculation remained essentially unchanged until 1938.

An index of prices based on conditions 30 years before came to be criticized as an unreal measure to relate to the agricultural industry of the 1930's. Specifically, the old index overweighted cereals, fat cattle and wool and underweighted milk, poultry products and vegetables. Since prices of these underweighted products had advanced more than those of other products, the index for 1935–36 constructed on 1908 weights showed an increase of 22 per cent. in prices

since 1911-13, compared with an increase of 36 per cent. for an index using values of output in 1935-36 as weights. Various minor discrepancies needed adjustment also.

As a result of the recommendations of a committee appointed in 1937 for the purpose, a new series of index numbers was started which forms a complete break with the old series. The new index uses the mean of market quotations for 1st and 2nd quality produce. Price relatives are computed with reference to the fairly stable 1927-29 period as base. In the composite index prices of individual products are weighted according to the estimated value, at base period prices, of the output in the five most recent complete crop years. The advantage of the compromise is that "... index numbers for years not widely separated should remain comparable, while on the other hand the weighting will always be representative of the output of a recent period" (112, 151).

As the prices of many products show a definite seasonal pattern, two series of monthly index numbers had been prepared prior to 1938, one using average prices in the calendar years 1911-13 as bases, and so being uncorrected for seasonal variation, and the other using the average prices in the corresponding month in the base period, thus being in some measure corrected for seasonal variation. As part of the general reorganization of the system of calculation in 1938, new monthly series were prepared using a more refined method. Each monthly index number is corrected for seasonal variation by dividing by an "index of seasonal variation" for that month. Though certain refinements are used, this index is essentially the mean of the values obtained by expressing each of the uncorrected indices for the corresponding months in the previous 10 years as a percentage of the 12-month average centred on that month. A composite index is also calculated monthly and corrected for seasonal variation. This index differs slightly in composition from the annual index.

In normal times perhaps the greatest use of indices corrected for seasonal variation is in allowing ready assessment of the extent of current trends in price level over a period of a few months. During the war fixed prices throughout the year were introduced for certain commodities, e.g., eggs, and seasonal variation in others has been deliberately accentuated, e.g., milk. The series of corrected indices for these commodities naturally shows a pronounced seasonal fluctuation—a measure of the degree to which war-time prices distort the customary price pattern. Even after a more normal seasonal scale is restored the series of corrected indices will for some years be difficult to interpret.*

Index numbers of the sale prices of a farm product do not necessarily measure changes in the producers' gross receipt per unit sold. The payment of a part of farmers' receipts for certain products other than as a "per ton" price has created numerous complications in the compilation of index numbers and in the arrangements for publication. The flat-rate subsidy per cwt. live-weight paid on all cattle reaching certain standards under the Livestock Emergency Provisions Act, 1934, and Livestock Industry Act, 1937, in effect merely raised the market price by a standard amount, varying only with the proportion of the different grades, which could fairly readily be estimated month by month. The deficiency payments under the Wheat Act, 1932, were less easy to handle since they were retrospective. With experience reasonably accurate provisional estimates were prepared and corrected as firm figures became available. The war-time device of paying for potatoes, wheat and rye partly "per ton" and partly by a payment per acre of the crop grown is dealt with for the purpose of calculating index prices by including in the per ton index price an allowance equal to the acreage payment divided by the forecast of the average sales of wheat and production of potatoes per acre of the respective crop.† These preliminary index numbers have been revised as firm estimates of production and output were made.

For the pre-war period and, for some commodities, for the early months of the war, when the government contribution to farmers' receipts in the form of cattle and milk subsidies, wheat deficiency payments, etc., were distinct, separate indices of prices "including" and "excluding government payments" were published. As the Government began to buy directly or indirectly the greater part of the farm output its subsidy contribution was no longer distinguishable and the separate series ceased. With the start of the acreage payments separate series of indices "including

* The series of indices corrected for seasonal variation was discontinued from August, 1950.

† In September, 1944, the allowance for potatoes was based on *sales*, but from July, 1947, calculation on the basis of production was resumed, previous figures being amended accordingly.

acreage payments" and "excluding acreage payments" were published. These "per acre" payments did not, of course, bear any particular relationship to the subsidy on the product. The part of the total remuneration of wheat growers to be paid on a per acre basis was determined in the light of production conditions. The aim of acreage payments was to make it reasonably profitable to grow the crop in conditions normally marginal without giving producers in favoured conditions excessive profits. It thus concerned the distribution between wheat growers of a given total remuneration for wheat, whereas the subsidy was related to the difference between the total remuneration and the value ultimately realized at retail.

The outbreak of war brought a fundamental change in the price statistics available on British agriculture. Pre-war, though reports were received from over one hundred grain markets, live-stock prices were received from only forty markets. These handled only a fraction of the total number of fat livestock marketed. Naturally the more important markets were chosen, but they may not have reflected trade conditions in the many minor markets. The classifications, particularly of livestock, used by reporters in quoting prices have been criticized (113, 114, 49) as both inadequate in detail and not comparable between markets. In contrast, from 1940 onwards centralized purchase (or, at least, closely controlled distribution) at fixed prices has made it possible to state in respect of the greater part of the agricultural output precisely what a producer received for a specified grade of product sold at a specified date and for each individual transaction to find its due reflection in summaries and averages, e.g. annual index prices. While this system continues similar precision in price definition can be expected.* For the future, there are at least two major problems. First, to secure a high standard of price statistics if centralized purchase as a means of implementing the assurances under the 1947 Act comes to be modified; and second, to improve price reporting for store livestock and other commodities which do not come within the system of guaranteed prices. Though there have been certain improvements in this field since 1939, the Market Reporting arrangements have probably not been severely tested (the "key" price statistics used in price negotiations having been taken from the fixed controlled prices) and most of the criticisms of the pre-war organization doubtless still apply.

The cessation of publication of the *Agricultural Market Report*, in spite of its limitations, is probably a loss to all producers. A reliable price-reporting service would naturally be valuable to producers of products for which forward prices are not guaranteed. For the products covered by price guarantees, price reports as such may under present arrangements be of little interest. A reliable qualitative guide to trade conditions may, however, provide experienced producers with very valuable pointers to probable future modifications in guaranteed prices which it would be to their own and the public advantage to anticipate. If the price of a product came to be supported through a deficiency payment scheme, reliable price reports would be as important to individual producers in selling their products as in a free market economy, and a necessity for the administering agency. To be of greatest use the publication of reports would need to be a good deal more flexible than was customary pre-war. A daily report, for instance, is needed for many vegetables. Broadcast market reports were helping to provide up-to-date information pre-war, but they hardly lend themselves to supplying comparative data for several regions or to dealing with the complexities of vegetable prices.

Utilization and Output†

The last two decades of the 19th century and the early years of the 20th was a period of great interest in agricultural output, especially in relation to national self-sufficiency. Numerous papers

* Somewhat offsetting the satisfaction which might otherwise be felt in this arrangement is the more limited interest of the price statistics which result. Quotations of free market prices, besides indicating what farmers receive, can be interpreted to give guidance on such matters as the regional and seasonal supply and demand situation of the product and its substitutes. In contrast, fixed prices, divorced as they now are from retail prices, can be related to little beyond the quantity of the particular product sold off farms and the production conditions.

† Output is defined as that part of agricultural production which is sold off farms for the use of the non-farm community together with the quantity consumed in farm households. Thus output excludes the produce which forms the raw material for further productive processes on farms in the U.K., such as store cattle and crops used as stockfeed. These items enter into output at a later stage as end-products leaving the "national farm".

appeared, some on British agricultural output as a whole and some on specific products, of which some of the most interesting are those by Rew (116), Lawes and Gilbert (115), and Turnbull (117). Though estimates of production of the major tillage crops were available from 1886, these studies were handicapped by the almost complete absence of information about production of livestock, and by the need to rely mainly on personal judgment as a guide to the utilization of crops. Statistics of sales of wheat, barley and oats and of numbers of livestock passing through certain markets were available in the Agricultural Statistics volumes of the period, but were difficult to relate to national totals.

The first official estimates of output in the United Kingdom were made in the Census of Agricultural Output in Great Britain in 1908 (1) and by the Census of Output of Ireland of the same year (118). These were particularly of value in providing estimates of output of livestock production and production of minor crops, but did not greatly advance the state of knowledge on the utilization of crop products. The importance of food supplies in World War I resulted in much attention being given to food statistics. Details of the actual movement of food products were obtained by the food control authorities, and the possibility opened for checking estimates of production, stock changes and disposal against each other. The figures for this period have been fully summarized by Beveridge in *British Food Control* (119). Further details of the production and utilization of wheat during World War I are set out in the Report of the Royal Commission on Wheat Supplies (120).

During this period, too, the first attempt to provide a complete balance-sheet of food supplies and requirements was made by a committee of the Royal Society (121). Estimates of supplies were derived from estimates of agricultural output based on the official estimates of production and expert judgment as to the course of utilization and estimates of requirements from nutrition standards.

In the post-war period the census of agricultural production taken in 1924/25, together with the information collected under the Board of Trade census of production in 1924, made possible a much closer appraisal of the actual output of British agriculture. Using the information so obtained, a comparison of the food supply in Great Britain before and after the War was made in the *Agricultural Output and Food Supply of Great Britain*, published in 1929 (122). A further census was taken in 1930/31 (5, 6). Thereafter the arrangements for carrying out censuses of agricultural production were modified so that sections of the industry should be treated each year. Thus fruit, glass-house produce and milk were studied in 1935 and 1936 (Ministry of Agriculture, *Agricultural Statistics*, 1936, Part II), but the outbreak of World War II prevented the development of this method of census-taking.

Data on Individual Commodities

The censuses of production of 1924/25 and 1930/31 had laid a rather insecure foundation for the statistical information on British agricultural output. A margin of uncertainty attached to most of the figures since the statistical inquiry from which they were derived was on a voluntary basis, so that the producers making the returns were naturally a biased sample of the whole. During the thirties new sources of material began to be available as a result of various marketing control measures. From 1934 the Milk Marketing Board recorded sales covering a large and increasing proportion of the total sales of milk for human consumption in England and Wales: similar data were obtained from the Scottish Boards (125, 126, *Journal of Scottish Milk Marketing Board*). Thus reliable figures became available for the first time for the bulk of the milk sold commercially. The proportion of producers covered by the Board's statistics steadily increased, so that by 1939 all but a small fraction of sales for liquid consumption and manufacture in Great Britain were included.

Under the provisions of the Livestock Emergency Provisions Act, 1934, and the Livestock Industry Act, 1937, and the subsidy scheme for fat stock which was developed as a result, statistics became available of the number of cattle presented for subsidy, the numbers eligible and the numbers accepted. These statistics related to cattle other than cows and bulls, and showed separately numbers of United Kingdom and Eire bred cattle, and numbers of steers and heifers. Stock accepted for subsidy, could, for practical purposes, be regarded as slaughtered forthwith. This material was published from time to time in the *Journal of the Ministry of Agriculture* (e.g.,

May, August and November, 1935; May and November, 1936; May and December, 1937), and, in considerable detail for the period August 1st, 1937, to March 31st, 1938, in the first Report of the Livestock Commission (127). These details of cattle sales by regions and by classes are of great interest, but their value as a basis for estimation of output is limited by the exclusion of steers and heifers not accepted for subsidy and of cows. Probably not more than about 10 per cent. of steers and heifers slaughtered were excluded from these statistics, but the omission of the considerable number of cows was much more important. There was, pre-war, no source of statistics of slaughterings of cows beyond the very approximate indication of annual wastage from the dairy herd which could be inferred from the annual return of livestock populations. The usefulness of this as a measure of beef production was further limited by the paucity of information about the number of cows disposed of other than for human food to knackers and kennels (128, 101).

Since for practical purposes the whole output of sugar beet was marketed through a limited number of factories, their records provide an estimate of output of unique accuracy (129).

Statistics of hop output only slightly less complete were also available (131).

In their report of the working of the Wheat Act of 1932 (132) the Wheat Commissioners gave details of their purchases and disposals of wheat in the period June 1st, 1932, to July 31st, 1937.

The marketing schemes for pigs and potatoes resulted in qualitative information of value in interpretation but no statistics of national coverage.

In addition to these non-official statistics the Ministry of Agriculture continued to publish the statistics of sales of wheat, barley and oats at certain markets as it was required to do under the Corn Returns Act, 1883, and also the number of fat and store livestock passing through certain markets. At no period has there been reliable direct evidence on the relation which these recorded sales bear to total sales in the country as a whole. The Corn Returns are known to include data from more than one stage in marketing and the same grain may be included twice, though such double counting should not be large. In spite of this they might be of value as a guide to changes during intercensal periods if the relationship could be assumed to have remained reasonably constant. However, apart from changes noted from time to time in the number of markets covered, it seems fairly certain that individual markets have changed their importance with changes in the prevailing channels of marketing. Consequently, though these records may give a useful guide to changes in sales from one year to the next, they must for other purposes be treated with reserve.

Responsibility for preparing calculations of output of the agricultural industry as a whole was assumed by the Agricultural Departments. Using the information collected at the censuses of production, and in late years, doubtless, the experience of the statisticians concerned with the marketing schemes, estimates of the quantity and value of agricultural output were prepared and published annually (e.g. *Agricultural Statistics, England and Wales*, 1939, Part I).

World War II

The detailed control of the production and distribution of food and other agricultural products, the close co-operation between traders and statisticians, and the vividness with which any shortcomings in coverage or accuracy of statistics were shown up by crises in distribution, brought great improvement in statistics of output. Four features in particular contributed. First the Government, or a closely controlled group of merchants acting as its agent, took ownership of all major farm products, both home-produced and imported, and arranged their distribution. The Ministry of Food and, to a lesser extent, the Ministry of Supply, were the departments chiefly concerned. So, for the first time, not only could a clear distinction be made between home-produced and imported produce, but also the quantity returning to the farms as feed or seed was known. Second, the close control of production exercised by the County War Agricultural Committees and the rationing of feedingstuffs on the basis of livestock numbers led to overall improvement in consistency of the basic statistics of agricultural production. Thus an appreciable number of holdings which had previously made no annual agricultural census return did so for the first time when the issues of rationed feedingstuffs for livestock were based on the numbers of livestock returned for census purposes. Thirdly, though food production off farms

greatly increased with consequent increase in the demand for raw materials produced on farms (e.g., seed potatoes, store pigs and pullets), the means of assessing the extent of these items of farm output, feedingstuffs rationing arrangements for domestic pig and poultry keepers and sundry licensing schemes gave a measure of guidance on the extent of non-farm production. Finally, in the comparison, matching and reconciling of statistical series relating to farm output the judgment of the ex-trader in the Civil Service, though he may not himself have thought in the same terms as the statistician, was invaluable.

Utilization of Agricultural Products

- Since recent estimations of agricultural output are for many products—especially crops and milk—dependent on statistics of the disposal of supplies, the preparation of a “utilization table”
- is a necessary preliminary step. Taking as an example the compilation at the end of 1946 of a table of estimates of utilization of the U.K. 1945 wheat crop, the statistics initially available include—

- (a) estimated gross production;
- (b) records of sales off farms to licensed buyers;
- (c) records of disposals by licensed buyers of wheat sold for seed and of wheat unfit for milling (for feeding);
- (d) estimates of wheat area for harvest in 1946.

Experienced observers can also form a reasonably reliable judgment of the usual seed requirement per acre sown, and of whether harvesting losses in a certain season were greater or less than average. A trial tabulation gives—

Total production in 1945 = (a) net disposals by licensed buyers to non-farm users, *plus*
 (b) seed for 1946 crop at standard requirement per acre \times 1946
 acreage with allowance for mixed corn area in 1946, *plus*
 (c) balancing item representing usage for feed, wastage and the
 errors in the other estimates.

War-time utilization of wheat represents the simplest example of utilization statistics, but products differ both in the variety of uses made of them and in the proportion of the crop for which firm statistics of utilization are available. The crude trial tabulations can be refined by allocations and adjustments based on trade judgments of the relative quantities disposed of through channels covered by statistics compared with those not so covered and crop reporters estimates of farm utilization. A balancing item appears in each table which, for crop products, is usually designated “waste”. It is important to realize that this item includes various forms of disappearance. For wheat it includes the obvious elements of whole grains, rotted, or eaten by vermin. The error in the original estimate as a measure of actual supply at harvest is also included, together with changes in the moisture content and the composition of *all* the original supply as a result of drying out and respiration between harvest and final disposal. Definitions of yield per acre and of the composition of the product at disposal are much too imprecise for this complex to be analysed into components. It is, however, important that its nature should be recognized if misinterpretation of the significance of the margin between estimated production and output is to be avoided. Even for such a dry product as wheat, drying out in stack may easily account for 2 or 3 per cent. of the original crop, and for potatoes, which both dry out freely in the early months in store and produce in the spring shoots which are rejected before marketing, these elements may account for several hundred thousand tons per annum. “Waste” of potatoes pre-war is estimated to have totalled some 0.4 mill. tons p.a. in the United Kingdom and from 0.7–1.0 mill. tons in the years 1941–42 to 1945–46. (compared with human use of some 3 mill. tons p.a. pre-war and 4–6 mill. tons in 1941–42 to 1945–46 (133, 42)).

These improved analyses of the utilization of agricultural products made it possible from 1940/41 to prepare estimates of agricultural output of an altogether higher order of accuracy than had been available pre-war. Moreover, comparison of the results of pre-war and war-time

procedures applied to war-time statistics made possible revision of the pre-war estimates of utilization and output. Estimates of the quantity and value of output of United Kingdom agriculture for 1936/37 to 1938/39 average and annually 1939/40 to 1945/46 are now available (133). Estimates for years up to 1947/48 and provisional estimates for 1948/49 are available for Scotland (134). Data for years up to 1946/47 have also been published for Northern Ireland (135).

The various combinations and elaborations of these estimates discussed below now provide a valuable appraisal of U.K. agricultural output. Unfortunately, in spite of the care and ingenuity which has gone to their preparation a considerable margin of uncertainty must be attached to many of the estimates. Some products, green vegetables for instance, present an inherently difficult problem for which there is no prospect of quick solution. In attacking certain other problems, a field inquiry of quite modest extent might result in useful headway. The extent of shrinkage of potato stocks in store, or at least the year-to-year variation in shrinkage, might be one of these. The outstanding characteristic of the present estimates of output, however, is their complete reliance on the records of the Ministry of Food. The question arises whether it is wise to rely on the results of combining national statistical series of such different origins without guidance from the application of the method to more manageable areas, e.g., parishes, counties or districts. Much more urgent, however, is the problem of securing the continuance of the series in the absence of the series now supplied by the Ministry of Food.

With changed conditions, methods of implementing the various guaranteed prices other than the purchase of agricultural products by the Ministry of Food or its agents might be devised. Though these might provide certain statistics, they may be less suited to combination with routine agricultural statistics than are the present series, particularly if statistical problems do not receive due attention during the early stages of organization. If so, a second series of estimates relating to output would be invaluable. Even the present series, useful as they are as global estimates, allow only crude analysis of output in relation to those characteristics of agriculture, e.g., crop acreages and production, livestock population, labour and machine force, which the regular agricultural statistics describe.

The present relatively high standard of the statistics of output compared with those existing pre-war should not be allowed to divert attention from the need for a long-term plan to prepare estimates of output closely integrated with other agricultural statistics. In practice it may need a return not only of crop acreages and livestock numbers, but also of production and output at least from a representative sample of farmers. Pre-war attempts to provide the information in the censuses of agricultural production were by no means successful, since the results of these voluntary inquiries were always biased to an unknown extent. Moreover, it is very difficult to trace whether produce sold off farms making a return ultimately goes, via a merchant, to some other farm and therefore must be excluded from "output". To secure representative results would raise complex statistical and administrative problems, and demand a degree of co-operation between farmers and statisticians that only a clear appreciation of the need for the results could foster.

Current Estimates of Agricultural Output

As they are now prepared estimates of output fall into three broad groups:

- (a) *Quantity of gross output*, consisting of a product-by-product tabulation of quantities sold off farms or used in farm households, together with an allowance for changes in the work in progress between the beginning and end of the year concerned.
- (b) *Estimates of the value of gross output*, being the quantities sold off or used in farm households valued at prices received for sales.
- (c) Statistics derived from the above, providing—
 - (i) composite measures of the "quantum" of output embracing all the varied products composing it;
 - (ii) a measure of the *net output* of agriculture after allowing for raw materials used in their production, e.g., imported feedingstuffs and store livestock.

The more important steps in the calculation of these estimates are described elsewhere (133, 134, 26). The analyses of utilization of home-produced agricultural products provide the basic

material for the estimates of output. Separate estimates have been published for Scotland and Northern Ireland (26, 135).

In estimating value of *gross* output these outputs of individual products are valued "at the farm gate". Certain other items in addition to these major products result from the efforts of farmers in a specified period. Sundry of them, e.g., output of goats' milk and increases in the carcase weight of livestock "on the hoof" between the opening and closing inventory, might be expressed in quantitative terms, but for conciseness of presentation are not. Others such as haulage services done by farmers and the differences in the effort represented by changes in the acreages under different crops between the beginning and end of the year can be expressed only in financial terms. Estimates of the value both of the various minor items and of the changes in valuation of crops and livestock are included in the complete estimate of the value of gross output.

The prices used in this valuation are net realization prices, including retail margins accruing to the farmer and deducting costs of carriage and agents' commission from prices quoted for points "beyond the farm gate". They include allowances for subsidies paid in effect as part of the price of the product. Thus they include not only those which appear as trading losses of the Ministry of Food, but also the acreage payments on wheat, rye and potatoes. They do not, however, include allowances for subsidies paid to assist a *system of farming* rather than an individual product, so that payments to farmers under the hill farming and lime assistance schemes are excluded. There are evident practical advantages in this, but since, under the present arrangements for guaranteeing agricultural prices, the overall economic position of agriculture and of various kinds of producers is reviewed before prices are determined, these subsidies can hardly fail to be reckoned over a period as if they contributed to the prices of the products concerned. To that extent the omission of these subsidies in this calculation is arbitrary.

The prices of different products at a given time provide a measure of their relative importance, reflecting a variety of attributes, including requirements of labour, land and equipment in their production, and the relative value placed on them by consumers or by Government. Thus prices provide a convenient basis of weighting, enabling all forms of output to be reduced to common terms. By valuing each item composing agricultural output, not at the price ruling when it sold ("current price") but at a constant price, a convenient single measure of the total output of agriculture is derived. Comparisons can thus be made of the level of agricultural output over a period during which the relative importance of different products within the total may have greatly changed. The comparative values of U.K. output at current and at constant prices are:

	Pre-war average	1939/40	1940/41	1941/42	1942/43	1943/44	1944/45	1945/46
	(£ million)							
Gross output at—								
Current prices . . .	284.9	349.1	439.9	498.8	566.4	597.9	579.7	615.1
Constant (1945/46) prices . . .	591.7	620.0	586.7	547.5	611.9	622.3	603.8	615.1
	(Index, pre-war average = 100)							
Current prices . . .	100	122	154	175	199	210	203	216
Constant prices . . .	100	105	99	92	103	105	102	104

The valuation of output at constant prices, though a useful device for allowing for changes in the pattern of output when appraising changes over a period in the overall total, takes no account of changes in the volume of inputs. Consequently statistics of "net output", obtained by deducting the value of inputs from the value of gross output, is a more critical measure of the results of farmers' efforts. Various opinions on the items to be included as inputs for the purpose have been discussed by Kirk (136). In broad terms the Agricultural Departments customarily deduct from the value of gross output the value of inputs derived from agriculture elsewhere—in practice, imported feedingstuffs, imported store and breeding livestock and imported seeds. These valuations are available both at current and at constant prices. The effect of the deduction is illustrated by the following valuations at constant (1945/46) prices :

These estimates are derived in broad terms from those of the gross value of output by the deduction of various elements of cost—rent of land, wages and salaries, purchases from other industries and abroad and provision for depreciation of equipment.

Derivatives of output and utilization statistics

Statistics of the utilization of agricultural products combined with data from various other sources have been used to provide, among other results, global measures of agricultural output per unit of labour, of feedingstuffs supply and the overall efficiency of U.K. livestock systems as converters of crops into livestock products, of the total and *per caput* human consumption of foodstuffs, and of the supply of plant nutrients in the form of artificial fertilizers and feed residues.

Output per Worker.—Only Scottish data are yet available (134). They indicate an increase of more than one-fifth since pre-war.

	1943/44	1946/47	1947/48	1948/49
			(Provisional forecast)	
			(Index, pre-war = 100)	
Net output at constant prices	141	124	126	128
Labour supply(a)	111	108	104	105
Output per worker	127	115	121	122

(a) Allowing for changes in composition of labour force.

These "increases in the net output per worker represent the rise in productivity which farmers and farm workers have achieved with the help of more machinery, more fertilizers, better drainage" (*ibid.*).

Food supply.—Detailed estimates of agricultural output combined with records of external trade and data on the production of industries processing farm products provide the opportunity to make studies of national supplies and requirements of food and livestock feedingstuffs.

The first reasonably comprehensive study of food supplies in the U.K. was that made by a special committee of the Royal Society in 1917 (121, 140). Though numerous studies were attempted during the 1930's, the first to show a definite advance in technique, being based on the detailed output and utilization tables discussed above, was the inquiry on food consumption levels in U.S.A., Canada and the United Kingdom (141). By standardizing the preparation of utilization tables the group making the study was able to derive the most reliable national and certainly the most nearly comparable international statistics of food supply yet made.

Feedingstuffs supplies.—In 1917, too, a careful estimate of feedingstuffs supplies was made by T. B. Wood (142), though he did not pursue the requirements side of the balance-sheet in detail. The subject again became topical in the late 1930's. N. C. Wright (143) studied the subject from the viewpoint of the dependence of the country on imported feedingstuffs. A detailed balance-sheet of supplies and requirements in terms of various nutrients was prepared by Leitch and Godden as part of their study of the efficiency of farm livestock as converters of feedingstuffs into human food (144). They estimated that feedingstuffs supplies in the U.K. in 1938 totalled 114×10^{12} calories, of which 29×10^{12} calories were of imported origin. Of the home-produced supplies, grazing was estimated to supply some 58 per cent. Some 8.7 per cent. of this energy supply was available for human consumption in the form of livestock products.

Plant nutrients.—Barker (145) made a somewhat similar comparison of the replacement of fertilizer nutrients to the U.K. soil during the periods pre-war and 1940-45, and the scale of removal in sale crops and livestock products. Production of nutrient in the soil, e.g., by nitrogen fixation, and the leaching of nutrients, were not included in the balance.

Miscellaneous Statistics

Statistics which can reasonably be looked on as representative, if not for the country as a whole, at least for important sections of it, are beginning to supplement observers' judgment in a number of fields. From 1942 onwards a Survey of Fertilizer Practice was carried out on a

reliable statistical design (146). Statistical data on the distribution of insect pests, e.g., wireworms (147), frit fly (148) and crop diseases (149) are beginning to become available, and arrangements for extending standardized reporting procedures are now being made. The characteristics of pest and disease damage, however, make combination of results of these studies with the more usual agricultural statistics, e.g., by making specific allowance for pest damage when forecasting crop yields, unlikely at least for a considerable time.

Certain statistics relating to livestock diseases are also available (e.g., numbers slaughtered because of foot and mouth disease), but not being designed for the purpose, they are difficult to relate to the usual national agricultural statistics. No comprehensive statistics of disposal of livestock other than for food are available, but analyses presented by Marley (101) suggest that during the war some 200 thousand head of cows and 60 thousand head of steers and heifers were annually so disposed of other than for food.

Very informative statistics bearing on livestock quality are now being published (150) by the Records Section of the Milk Marketing Board in the form of milk yields of milk recorded herds. Parallel data on feed conversion efficiency, carcase quality of meat animals, etc., are not, unfortunately, available on a similar scale.

Summary and Conclusions

The foregoing sections have indicated what an extensive and miscellaneous collection of data the U.K. agricultural statistics now comprise. It has been shown that the needs and opportunities of the last decade have brought about important changes and substantial improvements, and that legal powers exist for the collection of far more detailed information than has hitherto been sought. It remains to consider in what directions new developments are most urgently needed.

For over eighty years the results of the annual stock-taking of the crops and livestock on farms have provided an indispensable foundation for all estimates of production and supplies. In the 1930's, however, it became increasingly evident that the superstructure of estimation and conjecture which was being built upon them was more than they could reasonably carry.

It was not practicable to keep pace with the growing demands by expanding indefinitely the number of questions asked at each census. To some extent the situation has been relieved by the institution of special supplementary returns like those dealing with machinery, fruit, and glasshouse production, and it seems likely that this departure from the use of one comprehensive form sent once a year to all occupiers will prove to be permanent. The specialized systems of production carried on within "the agricultural industry" cannot properly be described within the categories provided by the general-purpose Agricultural Returns, but are too numerous and too important to the national economy to be passed over as exceptions which the statistics cannot recognize. The differentiation of several "populations" (e.g., commercial vegetable growers) within the general population of "occupiers of agricultural land" will probably continue and become more precise, though there will always be problems in defining the sub-populations and locating their members.

But it is not only in this respect that the June Returns have proved too inflexible. There is need for *continuous* knowledge of the U.K. agricultural situation, of a kind which general stock-taking at specified dates does not supply. Each year's agricultural output is in the nature of a margin or deposit of finished products which is detached from a larger volume of "work in progress", consisting of growing and harvested crops and livestock on the hoof. Little is known of the sequence of events through which the output element comes to be detached. Thus, though the grassland statistics show the net annual change in the total area under grass, no published figures describe the extent of ploughing-out and re-seeding of which this is the balance, nor the effect of farmers' grass policy on their crop rotations. Again, the Returns show net changes in livestock populations, but little can be deduced about the nature of the gross increments (by births and as imported stores, etc.), or of the outgoings (natural death, and slaughter for food and other purposes). An inventory does not indicate how soon after the date of the return the beasts are expected to be sold for slaughter—a very practical need in organizing livestock marketing. The course of events between census and census can at present be only dimly perceived, and there are no sample statistics to point the way. It is still possible for serious miscalculations of the short-term supply situation to be made.

Nothing approaching a complete and up-to-date description of the economic structure of the industry is possible on the basis of published statistics, nor is it possible readily to identify the types of enterprise which are most rapidly undergoing economic reorganization. Few data are available on landlord's or tenant's capital, rate of purchase of capital equipment or expenditure on improvements. In particular it is impossible to relate changes in output to changes in investment, or in the utilization of the different factors of production. The total output of a product cannot (with a few exceptions) be traced back to farm units of various degrees of specialization or scale of operations, and very little is currently known of the extent or manner of the combination of enterprises on farms. The statistics of agricultural labour make no differentiation in respect of skill or experience, and it is difficult to bring any statistical evidence to show in what regions or enterprises labour is being most effectively or most wastefully employed. Generally speaking, regional and local statistics of production and of the use of land, labour and capital are not presented in a form which makes it possible to identify the growing-points or the points of obsolescence within the economy. Closer analysis on these lines, repeated at frequent intervals, is suggested as a vital contribution to the realization of the purposes of the Agriculture Act, 1947.

Some of the aspects of agricultural production which have not yet been the subject of statistical inquiry will probably remain intractable (e.g., estimates of total nutrient absorption by crops), but one feature cannot continue to be left in obscurity. Grass is the most important of all British crops, but there is a complete absence of information on the quantity or quality of grass grazed by livestock. There are great difficulties in estimating—even on the scale of field experiments—the production of a crop which is "harvested" more or less continuously over the season, but the supreme importance of grassland makes an attack on these problems an urgent matter.

Not only will agricultural statisticians have great technical difficulties to overcome before all these gaps can be filled, but also much greater demands than hitherto will be made on the co-operation of producers. The speed of advance is likely to be closely governed by spread of appreciation of the value of statistics among all concerned with agriculture.

Finally, the method of presentation of the annual volumes of Agricultural Statistics seems to call for more emphasis on the current international situation in food production as it affects (or is likely to affect) British farming. This implies not only figures of quantities imported and exported by the United Kingdom, but also the corresponding values per unit and selected items from the agricultural statistics of the food-exporting countries. It is noticeable that the volumes of Agricultural Statistics published in this country before 1914 were more informative on these and other matters than those of the 1930's. What is required is authoritative statistical reporting, from the British point of view, of the international agricultural outlook.

References

Notes on Some Publications Cited

Since 1947 the three Agricultural Departments responsible for the collection of statistics in England and Wales, Scotland and Northern Ireland respectively have collaborated in joint publications entitled *Agricultural Statistics, United Kingdom*. Part I deals with acreage and livestock, production of crops, agricultural holdings, workers and machinery. Part II (a separate volume published at a later date) deals with the output and utilization of farm produce, and includes figures of the value of gross and net output. In addition each of the three Departments publishes its own volumes of Agricultural Statistics, giving more detail than is to be found in the joint United Kingdom volumes. When ordering these publications it is important to mention both the area (United Kingdom or otherwise) and the Part required. County figures for England and Wales and Scotland are published in *Agricultural Statistics Part I* for the country concerned. Part II deals mainly with prices and index numbers.

Before 1939 there were no separate United Kingdom publications, but the volumes for England and Wales contained United Kingdom statistics for all the major series. The weekly *Agricultural Market Report* of the Ministry of Agriculture and Fisheries ceased publication in September, 1939.

The official journal of the Ministry of Agriculture and Fisheries is entitled *Agriculture*, and is published monthly. From time to time it publishes statistics which are more detailed than those given in either the *Monthly Digest of Statistics* or the *Annual Abstract of Statistics*, and of more recent date than those given in the latest volume of *Agricultural Statistics*. Similar remarks apply to *Scottish Agriculture*, the quarterly journal of the Department of Agriculture for Scotland, and to the *Monthly Report* of the Government of Northern Ireland Ministry of Agriculture.

Farm Economics—miscellaneous notes on the economics of farming in Scotland—is issued twice a year by the Department of Agriculture for Scotland in collaboration with the three Agricultural Colleges in Scotland. It contains statistical tables and analyses which do not appear elsewhere.

The *Agricultural Register*, published annually from 1933-34 to 1938-39 by the Agricultural Economics Research Institute, University of Oxford, provided a summary of legislation, organization, supplies and prices for the year.

The *Farm Economist* is published three times a year also by the University of Oxford Agricultural Economics Research Institute. A regular feature introduced in 1947 consists of notes and statistics on supplies and prices.

The *N.F.U. Information Service* has appeared monthly since January, 1946. Each issue contains a useful statistical summary embodying recent official figures, and the articles frequently consist of statistical commentary and interpretation. There are also *Supplements* dealing with the results of the Farm Accounts Scheme.

Bibliography

- (1) Board of Agriculture and Fisheries (1912), *The Agricultural Output of Great Britain*. Cd. 6277. London: H.M.S.O.
- (2) Ministry of Agriculture and Fisheries (1927), *The Agricultural Output of England and Wales*, 1925. Cmd. 2815. London: H.M.S.O.
- (3) Board of Agriculture for Scotland (1928), *The Agricultural Output of Scotland*, 1925. Cmd. 3191. Edinburgh: H.M.S.O.
- (4) Ministry of Agriculture, Northern Ireland (1928), *The Agricultural Output of Northern Ireland*, 1925. Cmd. 87. Belfast: H.M.S.O.
- (5) Ministry of Agriculture and Fisheries (1934), *The Agricultural Output of England and Wales*, 1930-31. Cmd. 4605. London: H.M.S.O.
- (6) Department of Agriculture for Scotland (1934), *The Agricultural Output of Scotland*, 1930. Cmd. 4496. Edinburgh: H.M.S.O.
- (7) Ministry of Agriculture and Fisheries (1938), *The Agricultural Market Report*, 35, No. 5 (February 4th, 1938). London: H.M.S.O.
- (8) *Farmer and Stockbreeder*, 54, 350 (February 13th, 1940). London. (Weekly.)
- (9) Walker, L. M. (1938), "The tractor in Scottish farming," *Scottish Journal of Agriculture*, 21, 364 (October, 1938).
- (10) Department of Agriculture for Scotland (1949), *Agriculture in Scotland. The Report of the Department of Agriculture for Scotland for the Ten Years 1939-1948*. Cmd. 7717. Edinburgh: H.M. Stationery Office.
- (11) Ministry of Agriculture and Fisheries, Department of Agriculture for Scotland and Ministry of Agriculture, Northern Ireland (1947), *Agricultural Statistics, 1939-1944: United Kingdom, Part I*. London: H.M.S.O.
- (12) *Agriculture* (Journal of Ministry of Agriculture), 55, 271 (September, 1948).
- (13) *Scottish Agriculture* (Journal of Department of Agriculture for Scotland), 28, 113 (Autumn, 1948).
- (14) Ministry of Agriculture and Fisheries (1947), *Agricultural Statistics, 1939-1944. England and Wales, Part I*. London: H.M.S.O.
- (15) Department of Agriculture for Scotland (1948), *Agricultural Statistics, 1939 to 1944. Scotland, Part I*. Edinburgh: H.M.S.O.
- (16) Owen, Enid M. (1948), "Farm mechanization in England and Wales," *Yearbook of Agricultural Co-operation*, 1948 (Edited by the Horace Plunkett Foundation). Cambridge: Heffer.
- (17) National Farmers' Union, *Information Service*, 3, 189 (November, 1948). London: N.F.U.
- (18) — *Ibid.*, 3, 210 (December, 1948). London: N.F.U.
- (19) — *Ibid.*, 5, 115 (June, 1950). London: N.F.U.
- (20) United Nations. Department of Economic Affairs (1948), *A Survey of the Economic Situation and Prospects of Europe*. Geneva: Research and Planning Division, Economic Commission for Europe.
- (21) P.E.P. (Political and Economic Planning) (1949), *Agricultural Machinery. A report on the organization and structure of the industry, its products and its market prospects at home and abroad*. London: P.E.P.
- (22) Russell, Sir John (1949), *Presidential Address to the British Association for the Advancement of Science*. Reported in *Farmer and Stockbreeder*, 63, 2286 (September 6th, 1949).
- (23) Central Statistical Office (1946-), *Monthly Digest of Statistics*. London: H.M.S.O.
- (24) — (1948), *Annual Abstract of Statistics No. 85, 1937-1947*. London: H.M.S.O.
- (25) Raeburn, J. R. (1948), "Prices and costs," in *Farmer and Stock-Breeder Year Book*, 1948.
- (26) Department of Agriculture for Scotland (1950) *Agricultural Statistics, 1939 to 1944. Scotland, Part II*. Edinburgh: H.M.S.O.
- (27) University of Oxford, Agricultural Economics Research Institute (1939), *Farm Management Survey Scheme: Economic and Financial Study of Farming in England and Wales. Report No. 1. Years 1936 and 1937*.
- (28) — (1940), *Report No. 2. Year 1938*.
- (29) — (1940), *Preliminary Statement of the Financial Results of 1,350 Identical Farms in 1938 and 1939*.
- (30) — (1942), *Preliminary Statement of Financial Results for 1,764 Farms in 1940*.
- (31) — (1944), *Preliminary Statement of Financial Results for 1,828 Farms in 1942*.
- (32) — (1945), *Preliminary Statement of Financial Results for 1,875 Farms in 1943*.

- (33) Department of Agriculture for Scotland (1931-), *The Profitableness of Farming in Scotland. Reports on the financial results obtained on certain groups of farms in Scotland. No. 1. 1928-9 (1931).*
- (34) — (1932), No. 2. 1929-30.
- (35) — (1933), No. 3. 1930-1.
- (36) — (1934), No. 4. 1931-2.
- (37) — (1935), No. 5. 1932-3.
- (38) — (1936), No. 6. 1933-4.
- (39) — (1936), No. 7. 1934-5.
- (40) — (1937), No. 8. 1935-6.
- (41) — (1938), No. 9. 1936-7.
- (42) — (1939), *Scottish Farming. Tenth Economic Report. 1937-8.*
- (43) — (1946), *Scottish Farming. Eleventh Economic Report. 1938/39-1940/41.*
- (44) — (1947), *Scottish Farming. Twelfth Economic Report. 1941/42-1944/5.* Edinburgh: H.M. Stationery Office.
- (45) Government of Northern Ireland (1950), *Monthly Report*, 25, 40, 79 and 111 (June, July and August, 1950). Belfast: H.M.S.O.
- (46) Craigie, P. G. (1900), "Memorandum on the methods employed in the collection of annual agricultural statistics in Great Britain," *Bull. Int. Instit. Agric.*, 12, 322.
- (47) Rew, R. H. (1922), "The progress of British agriculture," *J.R. Statist. Soc.*, 85, 1.
- (48) Venn, J. A. (1933), *The Foundations of Agricultural Economics*. 2nd Edition. Cambridge: University Press.
- (49) Floud, F. L. C. (1927), *The Ministry of Agriculture and Fisheries*. London: Putnam.
- (50) Ramsay, J. M. (1940), "The development of agricultural statistics," *Journ. Proc. Agric. Econ. Soc.*, 6, No. 2.
- (51) Fussell, G. E. (1944), "The collection of agricultural statistics in Great Britain: Its origin and evolution," *Agricultural History*, 18, No. 4.
- (52) Ministry of Agriculture and Fisheries (1946), *National Farm Survey of England and Wales: A Summary Report*. London: H.M.S.O.
- (53) Stamp, L. D. (1948), *The Land of Britain: Its Use and Misuse*. London: Longmans, Green.
- (54) Kempthorne, O., and Boyd, D. A. (1946), "The stock-carrying capacity of farms," *J.R. Statist. Soc.*, 109, 469.
- (55) Bristol University, Department of Economics (1948), *Selected Papers in Agricultural Economics: Vol. I. National Farm Survey Studies. No. 1: Electricity and Water Supplies*, by Vernon Baker. No. 2. *Rent*, by Vernon Baker. No. 3. *Convenience of Layout, Situation and Permanent Equipment of Farms*, by Teresa M. Beynon.
- (56) — *Ibid.*, *Wartime Farming: One Hundred Farms, 1939-45*, by C. V. Dawe. [Bound in same Vol. as (55).]
- (57) Jones, R. B., and Wrigley, J. (1950), "Occupations and earnings of regular farm workers in Scotland," *Farm Economics*, No. 19, 3 (Spring, 1950).
- (58) London University South-Eastern Agricultural College, Wye, Kent (1945), *National Farm Survey: Results of some Investigations in the Wye Province*, by J. Wyllie.
- (59) University of Cambridge, Department of Agriculture, Farm Economics Branch (1947), *Report No. 30. Landownership in the Eastern Counties, 1941. A Study of the Distribution of Estates and the Standard of their Equipment*.
- (60) Department of Agriculture for Scotland (1946), *Agricultural Survey of Scotland*. Edinburgh: H.M. Stationery Office.
- (61) Government of Northern Ireland, Ministry of Agriculture, *Monthly Report*, 24, 38 (June, 1949). Belfast: H.M.S.O.
- (62) Ashby, A. W., and Evans, I. L. (1944), *The Agriculture of Wales and Monmouthshire*. Cardiff: Hon. Society of Cymmrodorian and Press Board of University of Wales.
- (63) Thomas, E., and Elms, C. E. (1938), *The Farms and Estates of Buckinghamshire*. University of Reading: Agricultural Economics Department.
- (64) Ministry of Agriculture and Fisheries, Department of Agriculture for Scotland and Ministry of Agriculture, Northern Ireland (1948), *Agricultural Statistics 1945: United Kingdom. Part I.* London: H.M.S.O.
- (65) Potato Marketing Board (1938), *The Area under Potatoes in Great Britain*. Misc. Publications No. 6.
- (66) Orwin, C. S., and Darke, W. F. (1935), *Back to the Land*. London: P. S. King.
- (67) Ministry of Agriculture and Fisheries (1949), *Smallholdings: First Report of the Smallholdings Advisory Council*. London: H.M.S.O.
- (68) — (1938), *Report on the Work of the Land Division for the Year 1937*. London: H.M. Stationery Office.
- (69) Central Landowners' Association, Ministry of Agriculture and Fisheries and Oxford University Agricultural Economics Research Institute (1949), *The Rent of Agricultural Land in England and Wales, 1870-1946*. London: Country Landowners' Association.
- (70) Department of Agriculture for Scotland (1948), *Scottish Farm Rents and Estate Expenditure*. Edinburgh: H.M.S.O.
- (71) Whitby, H., and Jones, R. B. (1948), "Farm incomes, rents and wages, 1939-40 to 1945-6," *Scottish Agriculture*, 28, 59 (Autumn, 1948).
- (72) Britton, D. K. (1949), "The sale value of farm land between the wars," *Farm Economist*, 6, 125.

- (73) Ashby, A. W., and Howell, J. Pryse (1927), "Rents and prices of agricultural land in South Wales, 1915-1925," *Welsh Journal of Agriculture*, 3, 5.
- (74) Heath, W. E. (1945), "A new classification of holdings," *Scottish Journal of Agriculture*, 25, 147. (July, 1945.)
- (75) Jones, R. B. (1948), "Labour employed per holding," *Farm Economics*, No. 16, 11 (Autumn, 1948).
- (76) Britton, D. K. (1949), "The distribution of agricultural workers in England and Wales by size of employment group," *Farm Economist*, 6, 80.
- (77) Gilchrist, J. A. (1947), "Staffing and field power on some dairy farms," *Farm Economics*, No. 13, 10 (Spring, 1947).
- (78) Beilby, O. J. (1947), "Tractors on Scottish farms," *Farm Economics*, No. 13, 11 (Spring, 1947).
- (79) Bowley, A. L. (1946), "Rural Population in England and Wales, 1911 and 1931," *Economica* (New Series), 8, 97.
- (80) Ashby, A. W. (1939), "The effects of urban growth on the countryside," *Sociological Review*, 31, No. 4.
- (81) Kyd, J. G., et al. (1948), *Scotland's Changing Population*. London: National Council of Social Service.
- (82) Thompson, R. J. (1937), "The agricultural labour bill in England and Wales," *J.R. Statist. Soc.*, 100, 607.
- (83) Hendry, G. F. (1949), "Farm workers' perquisites," *Farm Economics*, No. 17, 13 (Spring, 1949).
- (84) Pedley, W. H. (1942), *Labour on the Land: A Study of the Developments between the Two Great Wars*. London: P. S. King and Staples.
- (85) Government of Northern Ireland (1938), *The Conditions of Employment and Wages of Agricultural Workers in Northern Ireland* (1938) (Cmd. 199). Belfast: H.M.S.O.
- (86) Hobson, J. W., and Henry, Harry (1948), *The Rural Market: A compilation of facts relating to the agricultural industry and rural standards of living and purchasing habits*. London: Hulton Press.
- (87) Bowley, A. L. (1937), *Wages and Income in the United Kingdom since 1860*. Cambridge University Press.
- (88) — (1944), *The Wage-Rate Index-Number*. London and Cambridge Economic Service Memorandum No. 97.
- (89) — (1947), *Wages, Earnings and Hours of Work, 1914-1947, United Kingdom*. London and Cambridge Economic Service Special Memorandum No. 50.
- (90) Macgregor, J. J. (1946), "Labour costs in English forestry," *Forestry* (Journal of Society of Foresters of Great Britain), 20, 41.
- (91) Jones, W. H. (1938), "Insolvency in farming," *Welsh Journal of Agriculture*, 14, 63.
- (92) Rutherford, R. S. G. (1943), "Bankrupt farmers between the wars," *The Farm Economist*, 4, 95.
- (93) Department of Agriculture for Scotland (1947), *Scotland's Marginal Farms: General Report*. Edinburgh: H.M.S.O.
- (94) Beilby, O. J. (1947), "The problems of marginal farms," *Journal of Proceedings, Agricultural Economics Society*, 7, 306.
- (95) Todd Reference Books, Ltd. (1948), *Farming and Mechanized Agriculture, 1948*. (Advisory Editor: Sir R. G. Stapledon.)
- (96) Darke, W. F. (1942), "A short guide to pre-war English outdoor vegetable statistics," *J.R. Statist. Soc.*, 105, 328.
- (97) Ministry of Agriculture and Fisheries (1949), *Factors in the Marketing of Home-produced Apples in England and Wales*. (Economic Series No. 50.) London: H.M.S.O.
- (98) *Report of the Interdepartmental Committee on Social and Economic Research* (1948) (Cmd. 7537). London: H.M.S.O.
- (99) Messer, M. (editor) (1932), *An Agricultural Atlas of England and Wales*. London: H.M. Stationery Office.
- (100) Wood, H. J. (1931), *An Agricultural Atlas of Scotland*. London: G. Gill & Sons.
- (101) Marley, Joan G. (1947), "A statistical and economic survey of certain aspects of the beef-producing, milk-producing and cattle-rearing industries in Great Britain between 1939 and 1945," *J.R. Statist. Soc.*, 110, 187.
- (102) Dinsdale, D. H. (1950), "Hill sheep farming," *Journal of the Proceedings, Agricultural Economics Society*, 8, 272.
- (103) Coles, R. (1949), "A Study of the British poultry industry," *Journal of the Ministry of Agriculture*, 56, No. 7 (October, 1949).
- (104) War Office (1935), *Report on the Census of Horses in Great Britain, 1934*. London: H.M. Stationery Office.
- (105) Venn, J. A. (1926), "An inquiry into British methods of crop estimating," *Economic Journal*, 36, 394.
- (106) — (1927), "Crop-forecasting in England," *ibid.*, 37, 404.
- (107) Vigor, H. D. (1928), "Crop estimates in England," *J.R. Statist. Soc.*, 91, 1.
- (108) Raeburn, J. R. (1948), "The food economy of the United Kingdom in relation to international balance-of-payment problems," *Journal of the Proceedings, Agricultural Economics Society*, 8, 20.
- (109) Ashby, A. W. (1949), "Improvement of marginal land," *Town and Country Planning*, 17, 152 (November, 1949).

- (110) Kendall, M. G. (1939), "The geographical distribution of crop productivity in England," *J. R. Statist. Soc.* **102**, 21.
- (111) Houghton, C. T. (1938), "A new index number of agricultural prices," *ibid.*, **101**, 275-316 with discussion; **102**, 81-82.
- (112) Ministry of Agriculture and Fisheries (1938), *Index Number of Agricultural Prices*, 1938. London: H.M.S.O., 1938, pp. 42.
- (113) Dunnett, G. S. (1934), "Market intelligence: collection and uses," *Journal of Proceedings, Agricultural Economics Society*, **3**, 82-93.
- (114) Ministry of Agriculture (1934), *Report of the Reorganization Commission for Fatstock*. Economics Series No. 39.
- (115) Lawes, John Bennet and Joseph Henry Gilbert (1893), "Home produce, imports, consumption and price of wheat over 40 harvest years 1852-3 to 1891-2," *Journal of the Royal Agricultural Society of England*, **54**, 77-131 (3rd Series, Vol. 4).
- (116) Rew, R. H. (1892), "An inquiry into the statistics of the production and consumption of milk and milk products in Great Britain," *J. R. Statist. Soc.*, **55**, 244-278.
- (117) Turnbull, R. C. (1903), "The household food supply of the United Kingdom," *Trans. of Highland and Agricultural Society of Scotland*, **15**, 197-211.
- (118) Board of Agriculture, Ireland (1912), *Agricultural Output of Ireland*, 1908. London: H.M.S.O., 1912.
- (119) Beveridge, William Henry (1928), "British food control," *Carnegie Endowment for International Peace: Division of Economics and History: Economic and Social History of the World War*. British Series.
- (120) Royal Commission on Wheat Supplies (1921), *First Report with Appendices* (Cmd. 1544), pp. vi, 95. London: H.M.S.O., 1921.
- (121) Royal Society (1917), *The Food Supply of the United Kingdom*. A Report drawn up by a Committee of the Royal Society at the Request of the President of the Board of Trade (Cmd. 8421), pp. 35. London: H.M.S.O., 1917.
- (122) Ministry of Agriculture, England and Wales (1929), *The Agricultural Output and the Food Supplies of Great Britain*. London: H.M.S.O., 1929.
- (123) See (5).
- (124) See (6).
- (125) Milk Marketing Board (1939), *Milk Marketing Scheme: Five Years' Review*, 1933-38, pp. 59. London: Milk Marketing Board, 1939.
- (126) Agricultural Economics Research Institute, Oxford University, *The Agricultural Register*. Annually 1933-34 to 1938-39.
- (127) Livestock Commission (1938), *First Report. For the period August 1st, 1937, to March 31st, 1938*. London: H.M.S.O., 1938.
- (128) Economic Advisory Council, Committee on Animal Diseases, 1934. *Report*. Cmd. 4591. London: H.M.S.O., 1934.
- (129) *British Sugar Beet Review*, 17, 35 and 93.
- (130) University of Cambridge. Department of Agriculture, Farm Economics Branch (1945), *Report No. 29. Changes in the Economic Organization of Agriculture*.
- (131) *Brewers' Almanack* (annually).
- (132) Wheat Commission (1938), *Report of the Wheat Commission on the Administration of the Wheat Acts, 1932, from June 1st, 1932, to July 31st, 1937*. Ministry of Agriculture: Economic Series, No. 45.
- (133) Ministry of Agriculture and Fisheries, Department of Agriculture for Scotland, Ministry of Agriculture, Northern Ireland (1949), *Agricultural Statistics. United Kingdom Part II. Output and Utilization of Farm Produce in the Agricultural Years 1939-40 to 1945-6*, pp. 55. London: H.M.S.O., 1949.
- (134) Department of Agriculture for Scotland (1949), "Productivity of Scottish agriculture," *Scottish Agriculture*. Summer, 1949, 38-45.
- (135) Ministry of Agriculture, Northern Ireland (1948), "Output from the National Farm," *Monthly Report of Ministry of Agriculture*. November, 1948, 195-199. (See also November, 1949, issue.)
- (136) Kirk, J. H. (1945), "The output of British agriculture during the war," *Journal of Proceedings, Agricultural Economics Society*, **7**, 30-45.
- (137) Beilby, O. J. (1939), "Changes in agricultural production in England and Wales," *Journal of Royal Agricultural Society of England*, **100**. Part II, 62-73.
- (138) Heath, W. E. (1948), "Price-fixing policies in agriculture," *Journal of Proceedings, Agricultural Economics Society*, **8**, 4-13.
- (139) Treasury (1950), *National Income and Expenditure of the United Kingdom 1946-1949*. London: H.M.S.O. Cmd. 7933.
- (140) Wood, T. B. (1917), *The National Food Supply in Peace and War*. C.U.P., 1917.
- (141) Ministry of Food (1944), *Food Consumption Levels in the U.S., Canada and the U.K.* Report of a special Joint Committee set up by the Combined Food Board. London: H.M.S.O., 1944.
- (142) Wood, T. B. (1917), "The nation's fodder supply," *Journal of Farmers' Club*, May, 1917.
- (143) Wright, Norman C. (1940), "Britain's supplies of feedingstuffs," *Empire Journal of Expt. Agric.*, **8**, 231-248.
- (144) Leitch, I., and Godden, W. (1941), *The Efficiency of Farm Animals in the Conversion of Feedingstuffs to Food for Man*. Imp. Bureau of Animal Nutrition. Tech. Communication No. 14. Aberdeen, 1941.

- (145) Barker, A. S. (1947), "Supplies of some raw materials in British agriculture and their implications on soil fertility," *Journal of Proceedings, Agricultural Economics Society*, 7, 218-235.
- (146) Yates, F., Boyd, D., and Mathison, I. (1944), "The manuring of farm crops. Some results of a survey of fertilizer practice in England," *Empire Journal of Expt. Agric.*, 12, 163-176.
- (147) Ministry of Agriculture (1940), "Wireworms and other pests of newly-ploughed grass," *Agriculture*, 47, 87-98.
- (1941), "Wireworms and newly-ploughed grass land," *ibid.*, 251-257.
- (148) Thomas, I. (1948), "Insect damage assessment," *ibid.*, 55, 125-129.
- (149) Moore, W. C. (1949), "The significance of plant diseases in Great Britain," *Annals of Appl. Biology*, 36, 295-306.
- (150) Milk Marketing Board, *National Milk Records—Annual Report. England and Wales*. For years ending October 1st, 1945, 1946, 1947, 1948.
- (151) National Farmers' Union (1950), *The Agricultural Index Number*. N.F.U. Information Service. April, 1950, 72-77.
- (152) Britton, D. K., and Keith, I. F. (1950), "A note on the statistics of farm power supplies in Great Britain," *Farm Economist*, 6, 163.

1951]

REVIEWS OF STATISTICAL AND ECONOMIC BOOKS

CONTENTS

	PAGE
1.—Kendall (M. G.). Rank Correlation Methods	99
2.—Deming (W. Edwards). Some Theory of Sampling	100
3.—Mann (H. B.). Analysis and Design of Experiments	100
4.—Burn (J. H.), Finney (D. J.) and Goodwin (L. G.). Biological Standardization	101
5.—Perry (W. L. M.). Reports on Biological Standards. VI. The Design of Toxicity Tests	102
6.—Guilford (J. P.). Fundamental Statistics in Psychology and Education. 2nd ed.	102
7.—Maverick (L. A.). Economic Statistics	103
8.—Brockmeyer (E.), Halstrøm (H. L.), Jensen (A.). The Life and Works of A. K. Erlang	103
9.—Jensen (A.). Moe's Principle	104
10.—Jeffreys (J. B.), Maccoll (M.), Levitt (G. L.). The Distribution of Consumer Goods	104
11.—Delens (A. H. R.). Principles of Market Research	105
12.—Hartree (D. R.). Calculating Instruments and Machines.	106
13.—Kafka (F.). Statistics without Numbers	108
14.—Clarke (Charles E.). Social Insurance in Britain	108
15.—Seers (D.). Changes in the Cost of Living and the Distribution of Income since 1938	109
16.—U.S. Bureau of the Census. Historical Statistics of the United States, 1789–1945	110
17.—Saulnier (R. J.). Urban Mortgage Lending by Life Insurance Companies	110
18.—United Nations. Economic Survey of Asia and the Far East The Economic Development of Latin America and its Principal Problems	112
19.—Jasny (N.). The Socialized Agriculture of the U.S.S.R.	113
20.—Singapore Department of Social Affairs. A Social Survey of Singapore, 1947	114
21.—Other New Publications	115

1.—*Rank Correlation Methods*. By M. G. Kendall. London: Griffin, 1948. vii + 160 pp. 9s. 18s.

This book gives a valuable summary of the theory of ranking methods, a subject mainly developed by the author, as it was known up to the end of the year 1947. It is specially remarkable in having been written on a sandwich cake plan, a series of chapters on definitions and methods being alternated with a series of chapters dealing with the theory. This is a method which might well be used in other text-books, and has the advantage of making the book easily usable by the statistical practitioner and by the theoretician. Successive groups of chapters deal with rank correlation coefficients and their distributions, multiple and partial ranking, the relationship between rank correlation and product-moment correlation, and the method of paired comparisons.

There is little to criticize in the text. Some of the properties of the two coefficients of rank correlation (such as the fact that they lie between ± 1) could perhaps have been derived more obviously from their representation as product-moment correlations of scores. Equation (5.5) is open to misinterpretation as a result of a change of notation. Little is said about the power of tests, and the phrasing of some of the problems of estimation is perhaps a little questionable. For example, on p. 51, in dealing with estimation of a parental value of τ from a sample, it is stated that "the probability is 0.95 that the true value of τ lies within $(0.149 \times 1.96) = 0.292$ of 0.816". It should also be pointed out that the theory of the relationship between rank correlation coefficients and the product-moment correlation of an underlying continuous distribution has been developed much beyond what is described in this book by a subsequent paper by the author in *Biometrika*.

The book concludes with a valuable collection of tables of the distributions of various coefficients. Not only will the book be of great value to those, such as psychologists, who have to use ranking methods, but it will also help to direct the attention of mathematicians to an interesting subject full of unsolved problems.

P. A. P. MORAN.

2.—*Some Theory of Sampling*. By W. Edwards Deming. New York: John Wiley (London: Chapman and Hall), 1950. xvii + 595 pp. 9". 72s.

The years since the close of the war have been noteworthy, in the statistical field, for the spate of text-books which has poured out from the printing presses both here in England and in the United States. This in itself is a good thing, for no two persons think alike, and however often the early theory and applications are covered, some different illustration, some unusual form of words, throws new light on the whole subject. We have had during the past year the publication of two books which deal principally with sampling stratified populations, that by Dr. Yates and the present one by Dr. Deming. The two books, instead of being repetitive, are to a large extent complementary, and any student who is interested in sampling will find it well worth while to read Dr. Deming's book.

The author sets himself the two-fold task of instructing both the non-mathematical reader and the student of statistics who knows some mathematics. The first two chapters on the planning of surveys and the various errors of a survey are excellent: they are full of good sound common sense and contain some new thing for everyone. It can be said, without exaggeration, that where Dr. Deming concerns himself with the practical application of statistical methods to sampling, and in particular to the sample survey, he succeeds admirably both in teaching his reader and in encouraging him to think. Where the book fails is in its two-fold aim. Dr. Deming has, in fact, in trying to reach his two types of reader, written two books and fused them into one. While he is successful with his applications, it does not appear to the writer that the delineation and development of the theory of statistical methods will be satisfying either to the non-mathematician or to the mathematician. The non-mathematician will very quickly find himself troubled, while the mathematics student will find that he can read a statistical text-book with greater profit. It is to be regretted that Dr. Deming did not do what this present volume suggests he is eminently qualified to do, and that is write two books. If he had confined himself to writing his ideas and experiences in the planning of surveys his book would have had its place on most statisticians' bookshelves. As it is the statistician buying the book has to pay for a great deal which is expounded better elsewhere and, this being the case, the price is prohibitive of buying the book for oneself.

F. N. DAVID.

3.—*Analysis and Design of Experiments: Analysis of Variance and Analysis of Variance Designs*. By H. B. Mann, Professor of Mathematics, The Ohio State University, New York. Dover Publications, 1949. x + 198 pp. 7½". \$2.95.

The title of this little book is somewhat misleading, but it does fill a gap in the literature. It deals with the mathematical background of analysis of variance and experimental designs.

After preliminary chapters on the χ^2 and variance ratio distribution and on matrices and quadratic forms in relation to the multivariate normal distribution, the subdivision of sums of squares in a one-way classification is considered.

There follows a chapter on likelihood ratio tests in relation to linear hypotheses, because the author chooses to base the justification of the mathematical models used on the Neyman-Pearson theory of inference. He then goes on to consider the subdivision of the sum of squares in an r -way classification, and the power of analysis of variance tests. Next come some chapters on Galois fields and finite projective geometries in constructing sets of orthogonal Latin squares and balanced incomplete block designs. These should be especially useful, as it is the first time that a mathematical statistical text-book has dealt with the topics. Finally there are chapters on non-orthogonal data, factorial experiments, randomized designs, randomized blocks and quasi-factorial designs, analysis of covariance and interblock estimates and interblock variance.

In the introduction the author says: "The book is designed to serve three different purposes. First it was intended to enable a mature mathematician with no background in statistics to study the analysis of variance and analysis of variance designs within a reasonably short time. Secondly it is intended to serve as a text-book for a graduate or advanced undergraduate course in the subject. Finally it is hoped that the book will be studied by practical experimenters and statisticians who wish to study the mathematical methods used in the analysis of variance and the construction of analysis of variance designs, and are willing and able to expend the time and effort necessary for the purpose".

To the reviewer it seems that the last object is the most important. Read in conjunction

1951]

with a work such as Cochran and Cox's *Experimental Designs*, this book should be of the greatest value in providing the necessary mathematical background. But it is extremely doubtful whether a "mature mathematician" who had read only this book would understand analysis of variance. The method was invented to meet experimental needs; without constant reference to problems which actually arise in practice, its scope and purpose cannot be appreciated.

J. O. IRWIN.

4.—*Biological Standardization*. By J. H. Burn, D. J. Finney and L. G. Goodwin. 2nd ed. Oxford University Press, 1950. x + 440 pp. 8½". 35s.

Biological assay is concerned with the measurement of any stimulus, which may be physical, chemical, psychological, etc., in terms of the reactions it produces in a living subject. We use the biological method of measurement either because of the absence of any alternative, or because precise chemical or physical units have to be interpreted in terms of biological effects before practical use can be made of them. For the pharmacologist the subject is clearly quite fundamental. The great advances of recent decades in both the scope of biological standardization and the statistical design and analysis of the laboratory work involved is well illustrated by the series of books of which Professor J. H. Burn has been the sole or main author. His *Methods of Biological Assay* appeared in 1928. Nine years later, in 1937, there was a completely re-written version, which was the first edition of the volume now under review. Further progress since that time in both pharmacology and statistics has necessitated a new edition. Professor Burn has been fortunate in securing the services of Dr. Finney, who has contributed an excellent chapter on the use of modern statistical methods in biometrical assay, and also of Mr. L. G. Goodwin, who has been responsible for the chapters on the standardization of various chemotherapeutic drugs, many of which are of recent origin.

The first two chapters dealing with units of measurement and the classification of methods give a broad general introduction to the subject of biological assay. These are followed by Dr. Finney's lengthy chapter on statistical methods, which occupies rather more than a third of the whole book! This chapter is probably one of the best introductions to the statistical aspects of biological assay available at the present time, and could well be read as such more or less independently of the rest of the book. The emphasis of the treatment is everywhere on *statistical methods*, and avoids discussing points of purely mathematical interest. The account given is intended as a practical guide for pharmacologists in the design and analysis of routine assays. The clarity and lucidity of the exposition, together with the numerous carefully explained worked examples, suggests that this intention will be generally attained—though not necessarily at a first reading!

Readers of this journal will be specially interested in the ground covered by Dr. Finney in his survey of assay methods. After some introductory remarks there are two sections devoted to "Frequency Distributions" and "Estimation and Tests of Significance". These are immediately followed by a discussion of the heart of the subject under the heading of "Dose-response Curves". Regression, the analysis of variance, missing entries, litter-mate control, tests for the linearity of regression, etc., are all introduced at this point in the context of the main problem. In this way one avoids confronting the pharmacologist with apparently useless mathematical artefacts having no obvious application to practical problems.

The method of standardizing from a linear response curve is then considered, together with some of the objections to such a procedure. The simplest ways of avoiding these difficulties are treated in the next two sections, where considerable space is devoted to "Parallel Line Assays" and "Slope-ratio Assays".

The following section deals with data arising from binomial distributions, and the use of χ^2 for testing goodness of fit. The analysis of contingency tables is also discussed.

The next two sections are concerned with an exposition of the methods of probit analysis, which occupies a prominent position in the treatment of many kinds of assay.

The subsequent section, "The Design of Assays", deals with several valuable topics, including the use of pilot investigations, the optimum choice of doses, cross-over designs, validity tests, randomization, etc. This is followed by a final note giving some general hints on computational methods.

It is obviously impossible to give a comprehensive survey of modern statistical methods within the bounds of a single chapter—even so long a one as this—but it will be seen that quite a wide field is in fact covered. Within the inevitable limitations of space Dr. Finney has probably achieved the maximum possible. The mastery of at least elementary statistical methods is essential for the proper analysis and interpretation of results, and it can safely be said that a careful study of Finney's Chapter III, together with some reference to one or more of the standard text-books on statistics which he recommends, should enable the biologist or pharmacologist,

whose main concern is with problems of standardization, to have at his disposal a variety of valuable statistical methods.

Owing to modern advances, particularly the synthesis and crystallization of well-known substances and the discovery of new ones, the selection of topics for discussion in the chapters on pharmacological technique differs from that in the first edition. A few chapters have been omitted, including those on vitamin assay (except vitamin D), while much new material has been added. There are now new chapters dealing with the assay of atropine substitutes, local anaesthetics, analgesics, amoebicides, antimalarial compounds and many others. The accounts of these methods, which include small points of technique, are intended to enable a properly trained pharmacologist to carry out the tests without further explanation.

Although the subjects discussed in this book are considered mainly from the point of view of the standardization of drugs, it should be remembered that the question whether a new drug is better than an old one is frequently of the same type, the human patient replacing the experimental animal. It is to be hoped that this book by Professor Burn and his associates will be read not only by pharmacologists interested in standardizing their preparations, but also by those research workers in clinical medicine who are concerned with the discovery of new and better remedies.

NORMAN T. J. BAILEY.

5.—*Reports on Biological Standards. VI. The Design of Toxicity Tests.* By W. L. M. Perry, Medical Research Council Special Report Series No. 270. London: H.M. Stationery Office. 1950. vi + 51 pp. 9½". 1s. 6d.

This is the sixth of a series of Special Reports on biological standards issued by the Medical Research Council. The first (S.R.S. No. 69), written in 1922 by J. H. Burn and H. H. Dale, dealt with the assay of extracts of the posterior lobe of the pituitary gland by means of the isolated uterus of the virgin guinea-pig and established a technique that has remained in use for 25 years. The second (No. 128), by F. M. Durham, J. H. Gaddum and J. E. Marchal (1929), dealt with toxicity tests for the drug now known as neoarsphenamine. The third (No. 183), by J. H. Gaddum (1933), was a general discussion of the application of mathematical statistical techniques to the interpretation of biological assays based on a quantal response. The fourth (No. 202), by E. M. Hume and H. Chick (1935), dealt with vitamin A, and the fifth (No. 234), by C. W. Emmens (1939), with steroid sex hormones.

This report is a general study of the design of toxicity tests, but it is particularly concerned with routine tests of neoarsphenamine. At the time when Report No. 128 was written it was assumed that although individual mice in a colony might vary in their response, the average response of the whole colony would remain constant. This was subsequently shown to be untrue, though the original test seems to have sufficed to protect the public from toxic doses of neoarsphenamine. Theoretically, a manufacturer could have overcome his difficulties by procuring a hardier colony of mice rather than by improving his product.

This report shows how the difficulty may be overcome by properly designed tests based either on quantal or on graded responses. It contains nothing new in statistical technique or the methodology of experimental design, but is an admirably clear description of existing methods and their real purpose for the benefit of workers in this field. Dr. Perry emphasizes the now well-known principles that each test should be self-contained, should entail no arbitrary assumptions, and should provide an estimate of its own error. It must further provide evidence of the effect of each drug and the relation between dose and effect. The use of two doses of each drug satisfies these criteria. As an alternative to the quantal response technique he has himself devised a test based on a graded response-survival time—and this test is considerably more accurate. This means that fewer animals are really needed. The author has himself therefore made a most useful contribution to the actual practice of the subject.

J. O. IRWIN.

6.—*Fundamental Statistics in Psychology and Education.* By J. P. Guilford. 2nd ed. New York and London: McGraw Hill, 1950. xiii + 633 pp. 9". \$5.

This book will probably find its way into the libraries of most departments of psychology and education. Students in those subjects will find it a comprehensive storehouse of statistical methods, but if they want theoretical grounding they must look elsewhere. Broadly speaking, if such students are going to use advanced methods, they deserve and need a firmer grounding.

Standard methods are set out "up to, and including" introductions to analysis of variance and factor theory; there is a reference to Wald's book on Sequential Analysis. The introduction to analysis of variance, Chapter 10, is mostly on the methods of computation, so that it is doubtful whether readers will appreciate its value, or the desirability of appropriate designs. Other subjects,

1951]

such as the prediction of attributes, reliability of measurements and scaling procedures receive more generous treatment. Chapter 17 on reliability of measurements is probably the best in the book. There is a considerable display of special correlation methods and problems, Chapter 13, but the earlier chapter on correlation is superficial. The discussion of the important topics of the testing of hypotheses and methods of sampling will undoubtedly be helpful to students; but the superstructure rises from a brittle foundation of arbitrary significance levels.

As so often happens with books of applied statistics, the examples, even when drawn from the literature, are dead. It is quite unrealistic to suppose that one is doing anything with psychological implications in finding, say, the mean value of a set of numbers said to be scores on a test.

The most striking absentee is probit analysis, which is not mentioned even in connection with item analysis. The great majority of references are American; in several places work done and published elsewhere would have served at least to bring treatment up to date.

B. BABINGTON SMITH.

7.—*Economic Statistics*. By Lewis A. Maverick. Carbondale, Illinois, by the author, Students' Bookstore, Southern Illinois University, 1950. 2nd photo-offset ed. vii + 171 pp. 11". \$3.

This is "a syllabus or informal text in statistics designed for use in a short course for beginning students." The author, who is Professor of Economics at the Southern Illinois University, has divided the book into two parts, the first, category of distributions—measurements not ordered in time; and the second, category of distributions—time series (including index numbers). More than half of the book is devoted to Part II, and the chapters on time series are, on the whole, more satisfactory than the earlier ones. In particular the chapters on frequency distributions and correlation seem inadequate, partly on account of the author's definite and, it is felt, mistaken rule to disregard short-cut methods (on the ground that they require a mature appreciation of algebraic transformations) or alternative methods of solving a problem. Also, like many other introductory text-books, this one is more successful in teaching the straightforward methods of computation than in the much more difficult task of giving the student an insight into the meaning and significance of his results.

The great merits of the book are that it is very simply and concisely written and that it contains a wealth of excellent illustrative material—both tabular and diagrammatic. Although the book has no obvious general advantages over the elementary text-books available in this country, it should be found very useful in conjunction with statistics courses in American universities.

C. A. MOSER.

8.—*The Life and Works of A. K. Erlang*. By E. Brockmeyer, H. L. Halstrøm and Arne Jensen. Copenhagen: The Copenhagen Telephone Company, 1948. 277 pp. 9 $\frac{3}{4}$ ". (Trans. Danish Acad. Techn. Sci. (1948), No. 2.)

This co-operative work has been published by the Directors of the Copenhagen Telephone Company in memory of the late A. K. Erlang, and to celebrate the adoption of "the erlang" as the international unit of telephone traffic.

Erlang (who was born in 1878) joined the Company in 1908 as scientific collaborator and head of its laboratory. The appointment could not have been more timely; in the preceding year Fr. Johannsen (the managing director) had published two essays on the application of the calculus of probabilities to the mathematical problems associated with waiting-time and busy-signal systems, and he immediately suggested to Erlang that he should take over this work and develop it in a systematic way. A year later appeared Erlang's first paper dealing with these topics, and from then until his death in 1929 he remained the acknowledged world expert on the subject. Some indication of the pioneer quality of Erlang's work can be given by noting that his most important paper (1917) was eventually published in four different journals in as many languages. Two other workers in the field, A. E. Vulot and T. C. Fry, are said to have taught themselves Danish in order to read Erlang's papers in the original.

The first essay in this book (by Brockmeyer and Halstrøm) contains an account of Erlang's life. Several portraits and a note of his "heavy red full beard" suggest a striking personality. There then follows a long and valuable paper by Arne Jensen giving a unified account of Erlang's investigations from the standpoint of the modern theory of stochastic processes. This forms a very useful supplement to the collection of Erlang's own papers (translated into English), which are most interesting, but are not too easy to read by reason of the unfamiliarity of the notation and the occasional suppression of the mathematical working. Here will be found his original solutions to the now well-known waiting-time and probability-of-loss problems. A graph showing the distribution in duration of some 2,500 calls dealt with by Copenhagen main exchange enables

one to judge the adequacy of the negative-exponential distribution often employed in the theoretical calculations. Erlang most frequently used this or the assumption of a constant holding-time, but he also invented the idea of a multi-stage conversation leading theoretically to a distribution for the holding-time of χ^2 -form with an even number of degrees of freedom (which it has more recently been of interest to consider in connection with bacterial generation-times).

Erlang's own papers contain a number of tables of the mathematical functions required (including one for a Poisson distribution with negative mean), and the present volume is completed by Brockmeyer's table of Erlang's loss formula.

Telephone traffic is now said to have an intensity of m erlangs if m calls are expected during an interval equal to the mean holding-time. The quantity thus measured is of course dimensionless, and the erlang is to be compared with the octave, the stellar magnitude and the decibel in describing the mode of calculation rather than the unit of measurement in the usual sense of physics.

D. G. KENDALL.

9.—*Moe's Principle*. By Arne Jensen. Copenhagen: The Copenhagen Telephone Company, 1950. 160 pp. Charts. 9½".

The late K. Moe, Engineer-in-Chief to the Copenhagen Telephone Company, who in the course of his working at the operational economy of telephone exchanges occupied himself much with the Erlangian loss and waiting-time formulae, put forward in 1923 a rational method of balancing against the expense involved the advantage gained by introducing an additional connecting device in a telephone system. This caused great controversy, even among his colleagues, but "Moe's Principle" steadily gained ground, and just before Moe's death (in 1949) Arne Jensen was invited by the Company to produce the present work, which is a treatise on the rational application of the theory of probability to the management of telephone plant. The theory is based on "Moe's Principle", and the volume includes an extensive set of tables which is intended to facilitate the application of Moe's methods to practical problems.

Very briefly, the principle asserts that the decrease in the number of lost calls (or of waiting-time units) per unit of time obtained by adding one circuit to the group must be the same whether the number of circuits in the group is large or small.

Jensen's memoir commences with an account of the relevant parts of econometric theory, and then proceeds to derive a set of rules governing the optimum lay-out of a telephone system. The formulation is very general, and allows the optimum solution to be chosen in accordance with a wide variety of economic aims. (Thus it is possible to take account of the financial loss suffered by the subscriber during his waiting-time.) The mathematical details are rather complicated; in part this is a consequence of the discrete character of the independent variables (which implies that "differential" have to be replaced by "difference" methods throughout) but it is also partly caused by the fact that the optimum solution will frequently correspond to a boundary-point of the region of variation so that a stationary solution, even if it exists, may easily be the wrong one.

D. G. KENDALL.

10.—*The Distribution of Consumer Goods*. By James B. Jeffreys, assisted by Margaret Maccoll and G. L. Levitt (National Institute of Economic and Social Research, Economic and Social Studies, 9). Cambridge University Press, 1950. xix + 430 pp. 9¼". 35s.

Towards the end of the war the Executive Committee of the National Institute of Economic and Social Research was approached by a group of business men with the suggestion that the Institute should undertake an inquiry into the organization, methods and costs of distribution. The Committee welcomed the proposal and an advisory committee of economists and businessmen was established. It was decided that the study should relate to the last full year of pre-war peace—1938; that the approach should be by way of an intensive study of individual commodities, and that the information should be collected by personal interview, by correspondence and by questionnaire with the trade associations, leading manufacturers, wholesalers and retail organizations handling each commodity.

In presenting the results the book is divided into two sections. Part II, which takes up almost two-thirds of the book, is devoted to a series of case studies in which the information obtained about approximately one hundred commodities and commodity groups, is set out separately. Part I is a synthesis of the case studies and other material, wherein the author sets out in more general form an account of the methods, costs and structure of distribution and considers the factors which influence and determine these methods and costs.

Undoubtedly many readers will turn first to Part II. All these case studies are set out to a uniform pattern. The sequence of each is :

1951]

1. How much was spent by private consumers on the commodity in 1938; 2. an account of the methods of distribution—how much of the output went direct from the manufacturer to retailers, how much went through the intermediary of wholesalers; 3. how many wholesalers and retailers traded in the commodity; 4. the proportion of total retail sales handled by various types of retailers—e.g., multiples, co-operatives, unit retailers, etc.; 5. the “margins” earned by various distributors; 6. the average rate of retail stock-turn for the commodity, i.e., the average retailer’s annual sales of the commodity divided by the retail value of the average stock he carries of the commodity; 7. the amount spent by producers, wholesalers and retailers on distributing the commodity.

For the visually-minded reader, Charts I, III, IV and VI in the book provide a vivid comparison of the main data to be found in all the case studies.

In Part I the author stands back a little from his torrent of facts and considers the social and economic, rather than the business, problems of distribution. He starts with a general picture of how the nation’s output and imports of consumer goods were distributed in 1938. Their retail value was \$2,582 millions; 3 per cent. of the output passed directly from producer to consumer, 57 per cent. from producer to retailer, and the remaining 40 per cent. reached the retailer through the intermediary of one or more wholesalers. The variations between commodities were, however, enormous, for example, while almost 80 per cent. of fruit and vegetables went through wholesalers, practically all furniture (83 per cent.) went from the manufacturer either directly to a retailer or to the final consumer.

Producers’ distribution costs represented 5·5 per cent. of the retail price of all consumer goods, the margins of wholesalers about 4·3 per cent., and the margins of retailers about 27·2 per cent.—a total of 37 per cent. But again the variations from trade to trade were considerable; in some the total was well above 37 per cent., and in others well below. In some trades the producers’ distribution costs were very high (e.g., newspapers, coal, cosmetics), in others very low (e.g., jewellery, bread, meat). Once more it is in such variations that the author explains the factors which determine the costs of distribution.

Since 1938 conditions have changed in many ways. In some branches of the food trade the task of wholesaling has been taken over by Government departments. In some trades, e.g., newspapers and magazines, the physical volume of goods handled has greatly increased, while manpower and the number of retail outlets have remained constant. In others, e.g., confectionery, the inconveniences connected with rationing have reduced the number and changed the character of the main retail outlets. Again, relative expenditure on advertising has changed greatly; in 1938 a total of approximately £80 millions was spent on advertising a total retail trade of £2,580 millions; by 1950 the monetary value of retail trade had approximately doubled, while total advertising expenditure was still well below the pre-war figure. Again, there has been a shift in the character of the national output of consumer goods; before the war some 5 per cent. of the population had about 20 per cent. of the national income to spend on luxury goods where the costs of distribution were high; since the war the spending impact of this minority has been greatly reduced, and more and more manufacturers are selling their goods to mass markets. The consequences of these and other changes will, it is hoped, emerge from the present official Census of Distribution. Meanwhile statisticians, economists, administrators and business men are all under a considerable debt to Mr. Jeffreys and his colleagues for having carried out an enormous and complicated task in a way which will provide them with a reasonably reliable base line.

M. ABRAMS.

11.—*Principles of Market Research*. By A. H. R. Delens. London: Crosby, Lockwood, 1950. 254 pp. 9s. 15s.

The last few years have seen a growing realization by business executives of the value of market research, and many productivity teams have returned from the United States to add emphasis to this fact. Since there is, in fact, no other up-to-date book on the subject published in this country, this book could have filled an important gap in business and management literature.

It is designed mainly for students taking the National Diploma in Management or the examinations of the Sales Managers’ Association, the Advertising Association, and some other professional bodies which set papers in market research techniques.

There is much good common sense in it, although the approach to certain marketing problems is naïve. Since it is primarily meant to give background information to students and others unfamiliar with the techniques, naïveté may be pardonable; but technical errors, of which there are a number, are not. In view of the undoubted ability of the writer it is regrettable that he should discuss sampling theory and other statistical concepts with which he seems unfamiliar. This is particularly unfortunate, since he devotes five of his eighteen chapters to statistical theory

and practice. When the book comes to be revised (and this should not be long delayed) some one should also see that no apparent contradictions appear, as indeed they do at present.

As evidence of *naïveté* only one example may be quoted:

"People may think up what they consider to be suitable answers through the very human weakness of pride. Unless *Interviewers* are aware of these failings and are trained to recognize them, they will not check the replies given, with the result that they will be given without qualification" (p. 19).

In another place Mr. Delens says, more reasonably, that too much responsibility must not be left to field staff. Surely the design of all questions to be used is the task of the research editor, and should never be left to the several interviewers?

Perhaps some reason for the errors is revealed by the following quotation (p. 28):

"By survey methods it is comparatively simple to test the effectiveness of particular advertisements by measuring the reactions of consumers to them, the extent to which they are noticed and remembered and their influence on purchases".

Mr. Delens seems unaware that people will "recognize" posters and advertisements which have never appeared. Far from being any simple matter, there is little doubt amongst practitioners of market research that advertisement research is one of the more difficult and controversial fields of inquiry.

The author gives a short list of sources of statistical data of value in market research, but fails to mention the *Monthly Digest of Statistics*, although he refers to the Annual Abstract. It would surely have been better to refer the "perambulator manufacturer" to the Quarterly Returns of the Registrar-General than to imply that he should write to that department to obtain birth rates in "various places".

A selection of only one or two statistical points can be given. On page 81 there is a diagram showing two curves—the y -axis being "number of samples", and the x -axis the "proportion of respondents giving an answer A". One curve is normal and the other platykurtic, almost rectangular. It is stated below this diagram, "Both are normal curves . . .", and later, "In market research the curves approximate to normal for samples of more than about 50". Nothing in this discussion is said about the values or limits of p , and for some reason the x -axis ("proportion") ranges from 0 to 150. The reader is also informed that the "curve is symmetrical so that proportions less than p are just as likely to occur as proportions greater than p ".

A chapter which in fact deals with the accuracy of the mean is headed "Accuracy of σ ".

On page 82 the formula $\sigma = \sqrt{\frac{pq}{N}}$ is given, and the reader is informed that "this formula will give the standard error for any sample".

Quota sampling we are told is the same thing as a "stratified sample", and the modern methods of stratified random sampling are not mentioned at all. "It is seldom possible," continues Mr. Delens, "to conduct the survey by personal interview where a random sample has been selected unless the universe is fairly limited and the area concerned fairly small". Again, on page 80, the author states when referring to a "stratified sample" (i.e., a quota sample in his terminology), "This procedure makes the results very much more accurate than when a strictly random sample is taken, but it also makes it extremely difficult to work out the exact size of the error which is likely to occur". It would be instructive if the author would quote the formula for calculating the error of a quota sample "exactly", however difficult it might be.

L. T. WILKINS.

12.—*Calculating Instruments and Machines*. By D. R. Hartree. First edition to be published in England. Cambridge University Press, 1950. ix + 138 pp. 9½". 21s.

This book consists essentially of a short series of lectures delivered by the author at the University of Illinois in 1948. The book can be confidently recommended as an introduction to modern methods of large-scale calculation, and even the expert will be glad to possess a copy.

In Chapter 1 non-human computers are classified into "instruments" (continuous computers) and "machines" (discrete computers). Chapters 2 to 4 deal with the differential analyser and with other continuous computers, and Chapters 5 to 9 with general-purpose digital computers (mainly electronic and relay). There is ample discussion of numerical methods in relation to machines, and there are several interesting historical remarks, including, for example, some concerning Byron's daughter, Lady Lovelace. There are 68 diagrams and photographs, including a photograph of the useful Mecanno differential analyser built by Hartree and Potter. There are no ordinary electrical circuit diagrams. This is because the book is more concerned with "physiology" than with "anatomy".

In Chapter 2 it is made clear how the use and flexibility of the differential analyser depends on the possibility of topological rearrangements of its basic units, so to speak. It is therefore

1951]

not surprising to be told that differential analysers which have electrical connections rather than mechanical ones are at a considerable advantage.

In Chapter 3 the fundamental effect of the boundary conditions of ordinary and partial differential equations is emphasized. An example is given to show how the boundary conditions of a partial differential equation can influence whether one or another continuous independent variable should be replaced by a discrete variable (for differential analyser purposes). The use of "characteristics" of partial differential equations is also considered.

In Chapter 4 some miscellaneous continuous computers are briefly described, including Mallock's machine, the Isograph, Fourier synthesizers, and special types of integrators.

Chapter 5 is an introduction to large automatic digital computers. The author is careful in his choice of technical terms. He expresses dissatisfaction with the term "judgment", but uses it occasionally. Perhaps "decision" or "ability to decide" (according to context) would be better. As a matter of fact decisions can be made even by some electrical desk computers (when carrying out divisions), and for these computers the term "judgment" is particularly inappropriate. The distinction, however, between a "judgment" and a "conditional selection" is not entirely clear to the reviewer.

Chapter 6 deals briefly with the "Analytical Engine" designed by Charles Babbage a century ago (but never completed).

Chapter 7 is concerned mainly with the Harvard Mark I Calculator, which is electromechanical and controlled by 24-hole tape, and with the Eniac, which is electronic, but in 1948 had no really modern methods of storage. It is pointed out that the Eniac is a good machine for the purpose for which it was built, in spite of its limitations when regarded as a general-purpose computer. In particular the manual plugging of instructions makes it easy to correct minor errors in the instructions. At the end of this chapter the necessity is pointed out of taking a "machine's-eye view" when programming a calculation.

Chapter 8 is concerned with the more modern developments. In particular a control circuit of the intriguing Ace type is given in the McCulloch-Pitts-von Neumann-Turing notation. The distinction between serial and parallel machines is made. A typical remark is that in a serial machine the adder is comparatively simple, and that one can therefore afford to duplicate it in order to obtain a check on all additions. This chapter concludes with a short section on "programming and coding". The last paragraph of this section is very important, though it is slightly out of place.

The last chapter is concerned with numerical analysis in relation to high-speed computers. The value of iterative processes is stressed.

On page 61 a prediction is made that the decimal representation of numbers will probably oust the binary representation in general-purpose computers, partly because of the greater ease of "trouble-shooting" when the decimal representation is used. This may well be true for computers in the strict sense, but in general-purpose machines intended for logic, for pure mathematics in general, for the theory of numbers in particular, and for the analysis of the nervous system, the binary representation is liable to remain more convenient (except perhaps for multi-valued logics). It cannot be predicted for any of these subjects that their mechanization will not ultimately become of great practical importance.

The author has an open mind on the "exciting" question of whether machines will be constructed which will "think for themselves", i.e., which will handle symbols in a non-predictable but useful manner. If this will be possible for future machines, then it is presumably also possible (though perhaps inconvenient) for machines designed before 1948, a fact which the author has apparently overlooked. It is a question of producing a suitable programme. This question has received some attention from Turing and others. A randomizing device would be required, and could be supplied by placing random numbers in the store. The author is clearly right in using the word "exciting", since a machine which was so nearly human (or perhaps superhuman) could become a modern oracle. The threshold between a machine which was the intellectual inferior or superior of a man would probably be reached if the machine could do its own programming. Such speculations would be contrary to the matter-of-fact style of the book.

The brevity of the style often stimulates thought. For example, on page 65 there is a suggestion that a compromise between a floating and a fixed binary point may be advisable, and the reader's intelligence is complimented by the omission of specific details.

There are naturally some additional matters which could have been included with advantage. For example (i) some estimates of relative costs, though these estimates may become out of date rather quickly. (ii) A mention in the historical remarks of D. H. Lehmer's photo-electric factorization machine. (iii) Titles of the articles in the References. (iv) Approximate numbers of valves (tubes) required to produce a threshold- n element. (v) Insertion of Mallock in the name index.

I. J. GOOD.

13.—*Statistics without Numbers: Visual Explanation*. By F. Kafka. New York: Lifetime Editions, 1950. 111 pp. 9". \$2.

This little book is designed to explain statistical ideas to the layman by means of diagrams. The whole volume does not contain one statistical table, though it deals with concepts like averages, dispersion, correlation, sampling and the normal curve. Generally speaking the exposition is remarkably clear, though occasionally the desire for simplicity is pushed too far. Thus the layman who wishes to understand what is meant by a variance will find little help in this book: the description of this most important measure of dispersion is perhaps the least successful part. Another criticism which might be made against the author is that he pays too much attention to commercial and business applications of statistics, and does not mention the increasingly important part played by statistics in other fields.

The book reads very easily and is attractively produced. It might well be put into the hands of young persons who would like to have some idea of what statistics is about.

E. GREBENIK.

14.—*Social Insurance in Britain*. By Charles E. Clarke, F.I.A. London: Cambridge University Press, 1950. x + 136 pp. 13s. 6d.

The fundamental principle of insurance that risks should be spread, i.e., that those individuals who, in the event, suffer the contingencies against which provision is sought by all, may benefit from common thrift, has long been accepted in this country. Nice calculations of equity which arise have provided the professional calling of actuaries, whose training and experience have made them the sure custodians of the pooled assets which furnish the strength of British Insurance Institutions. It was inevitable that in the extension of the principle of insurance to State schemes of social security actuaries should play an essential part, and that consequently social insurance should occupy an important place in the syllabus of their professional examinations.

This book brings together knowledge and experience which the student has been hitherto forced to seek in many scattered papers and official publications. It is part of a series of textbooks published under the authority of the Institute of Actuaries and the Faculty of Actuaries, and designed to meet the needs of students preparing for the actuarial examinations. But it will have a wider appeal as a thorough account of the actuarial and financial aspects of social insurance schemes, with particular reference to the comprehensive national insurance and industrial injuries schemes introduced in Great Britain in 1948. The repercussions of social insurance upon the whole mode of life of society is patently of interest to economists and sociologists, and since considerations of social justice and actuarial principles are inseparable, there is much information of value to them in this admittedly highly technical text-book.

Before dealing in detail with the schemes in force at the present time the author enhances the perspective of the reader with an historical account of the origins and development of British social insurance. Reference to direct actions of charity by the Church or indirect charity implicit in the Poor Law, though admittedly necessary to complete the picture, is, however, to be criticized on the ground that it is not made clear that they are not schemes of insurance. To the extent to which men contribute equal sums to a pool to cover a common risk, as in ordinary private life insurance, this is not charity, but insurance. To the extent to which the Government may subsidize a security scheme by taxing the more prosperous population, or by requiring them to pay a contribution equal to that of the poorer sections of the community, though their risks are smaller, there is an element of charity. There is some confusion of these two aspects which could have been avoided, though it is admittedly resolved in the ensuing section on basic principles. This section makes clear the very limited relationship between benefits and earnings, and the firmer relationship between contributions and benefits which have been accepted in British practice. A special chapter is devoted to the description of those fundamental notions of social security crystallized during the World War of 1939-45, and associated with Lord Beveridge. The manner in which these ideas determined the pattern of subsequent legislation is indicated.

Then follows an extremely clear outline of the National Insurance Scheme, with fuller detail consigned to an Appendix so as not to hinder the digestion. This is good teaching, since it enables the student (and the general reader) to get a broad picture before attacking finer points of detail.

The discussion of the actuarial basis will be of interest to all demographers in showing the wide range of population statistics entering into the calculations—from proportions employed to the remarriage rates of widows. The actuarial student will gain much from the author's method of treatment, which consists in taking section by section the Government Actuary's published Report on the actuarial estimates and commenting on the main points of interest in each section. The formulae used in making the estimates of cost are adequately explained, with a clear description of the notation used. These formulae will appear frightening to the non-technical reader, but it

1951]

should be explained that the actuarial student does not come to social insurance until after he has already mastered the basic elements from which such formulae are constructed. Discussion of emerging expenditure is illustrated by diagrams which analyse the contribution to show how great a part goes toward each benefit, and which show how the expenditure increases with the growth of the numbers coming into benefits of different kinds.

The book, though short, is commendably complete, and if consequently concentrated, is not difficult reading for those who come to it seriously. Much of the comparative ease of reading is due to the careful breakdown of the subject into sections and their logical arrangement.

B. BENJAMIN.

15.—*Changes in the Cost of Living and the Distribution of Income since 1938.* By Dudley Seers. Oxford: Basil Blackwell, 1949. 84 pp. 9½". 6s.

The 84 pages of Mr. Seers's book clearly represent the fruits of a great deal of patient and careful work, and contain far more valuable matter than can properly be dealt with in this review. Essentially he has been trying to take over where the official statisticians stop, and to bring together data from a variety of sources so as to estimate a lot of things on which information is badly needed, e.g. the rise in prices from 1938 to 1947 as it affected different social classes, or different types of income, and the combined effects of these price movements, changes in taxation and the changed distribution of gross incomes on the distribution of real net income.

Mr. Seers is clearly aware that grave dangers are involved in this process of using statistics, which are themselves estimates, for purposes which their authors often did not have in mind, but he says in his preface that he considered "the provision of data on current social and economic problems sufficiently important to justify squeezing what information one can from the scanty sources available". This is probably the right attitude, but it calls for some very awkward value judgments in interpreting the results. Thus, on page 12, Mr. Seers decides to deduct 10 per cent. from his estimate of the average working-class expenditure on fuel and power (based on the 1937/38 budgets), because he considers it obviously wrong that this should be shown as above the national average; his objection is clearly justified, but the figure of 10 per cent. is wholly arbitrary, and in using the results for further calculations he frequently suggests that it should have been bigger. There is no particular reason for assuming that fuel and power was the only unreliable group, merely because the others (apart from drink and tobacco) do not lead to results which are "obviously" wrong; we are left with an uncomfortable feeling that every "striking" result really needs to be scrutinized to see whether it suggests a flaw in the basic data rather than an important conclusion.

Mr. Seers only makes a limited attempt to tackle this problem, even in the (regrettably rare) cases where any indication of the reliability of the basic data is published. It seems clear that his kind of analyses demands the closest collaboration with the compilers of the original statistics if we are to know which results can be treated as approximate answers to the questions posed, and which merely call for a review of the original data. Moreover, such collaboration will often lead to greater reliability in the results, through the provision of supplementary unpublished information and a more correct interpretation of the published figures.

Unfortunately Mr. Seers seems to have confined himself exclusively to published material, and goes to great lengths to deduce or estimate things on which he could probably have had exact information for the asking.* He does not seem to have attempted to find out how reliable the various published figures were, and whether they could plausibly be used in the ways adopted (e.g. for finding *differences* between the movements of prices as they affected various classes).

One result of this non-co-operation unfortunately has far-reaching implications. Mr. Seers refuses to accept at its face value the Ministry of Labour's explicit statement that their information about price changes between 1938 and 1947 was insufficient to carry the index of retail prices back to 1938, although it was sufficient for a reasonable estimate of the 1947 weights corresponding with the 1938 budgets. He successfully deduces from the description of how the weights were calculated that the information used for adjusting them implied a rise in this (working class) index of 61–62 per cent., and then proceeds to deduce how large the rise must have been for the rest of the community in order to give the over-all rise of 68 per cent. shown in the national income white paper; and this result is used in a lot of further calculations.

Now it may be reasonable to say that the implied price rise of 61–62 per cent. was sufficiently reliable to justify publication as an order of magnitude, even though it was only an incidental by-product of a calculation made for another purpose, which did not call for the "care" attributed to it on page 19. But there is no doubt that it was far too uncertain to justify its use for a *difference*

* A considerable part of his difficulty over the expenditure on fuel and power mentioned above would have been resolved if he had found out how much the Technical Committee had assumed to represent the purchase of matches and the hire of gas and electric appliances.

calculation of this kind, even apart from the fact that the White Paper estimate itself is the by-product of an avowedly hazardous calculation primarily concerned with volume changes and so exposed to a quite different set of errors. This part of Mr. Seers' calculations, though extremely ingenious, rests on such uncertain foundations that the value of the results is very problematical.*

This review has been mainly devoted to one theme because it is of real importance. Space does not permit a detailed account of the book's very real merits, which would be needed to give a balanced picture. Mr. Seers has produced some results of great interest, and even where he seems to have overstrained the data his analysis shows how important questions *could* be answered, if the necessary basic data were collected.

W. B. REDDAWAY.

16.—*Historical Statistics of the United States, 1789–1945: a supplement to the Statistical Abstract of the United States.* Bureau of the Census: Washington, D.C., 1949. viii + 363 pp. 11½". \$2.50.

This unique volume brings together no less than 3,000 statistical time series relating to the United States for various periods from 1789 to 1945 covering Wealth and Income, Population and Migration, Vital Statistics, Health and Nutrition, Labour Force, Wages and Working Conditions, Agriculture, Land, Forestry and Fisheries, Minerals and Power, Construction and Housing, Manufactures, Transportation, Price Indexes, Balance of Payments and Foreign Trade, Banking and Finance, and Government. The material was prepared and edited in the Bureau of the Census with the help and advice of the Social Science Research Council and a number of other agencies and individuals. It is an outstanding example of fruitful co-operation between Government and private statisticians.

The object is described as two-fold, "first, to bring together for the convenience of users of statistics the historical series of wide general interest; and second, to provide through brief descriptive text and precise source notes a guide to the types of historical data available, so as to inform the user where further data can be obtained". The Introduction makes it clear that this first edition is an experiment: it is hoped that readers will send in suggestions and criticisms, in the light of which a revised edition will be produced later. An extraordinary amount of detail has been assembled under each head, and scrupulous care has been taken to point out the limitations of the data and the source of each series. Every statistician, economist and economic historian will find this book indispensable.

Two things are bound to strike the British reader when he delves into this admirable volume. He will be led to think immediately of those fields of historical statistics where America is rich and Britain poor, and he will try to find out the reasons. One has the impression that the work of organizations such as the National Bureau of Economic Research has given the United States a great advantage, whereas in this country some of the more notable achievements have been the fruit of single-handed effort such as that of Bowley and G. H. Wood on wages. The Americans have always been prepared to spend much more money on statistics than we have, and their harvest in several fields is correspondingly more abundant. This leads to a second reflection. One result of the publication of the volume under review will be to draw attention to gaps and weaknesses, and American statistics will be further improved. Surely the time has come for a similar project to be launched in this country. While there has been a great advance in certain branches of statistics, e.g., the national income, recent progress in other spheres has been somewhat dubious, e.g., the effect of the creation of the Ministry of National Insurance on our labour statistics. Moreover, the regional information compiled here is ludicrously inadequate compared with the corresponding data available in the United States. The needs of research workers no less than those of policy makers are a compelling reason for the publication of a British compilation similar to *Historical Statistics of the United States*. Whitehall will surely not fail to respond if the opinion of universities, research institutes and learned societies can be fully mobilized.

BRINLEY THOMAS.

17.—*Urban Mortgage Lending by Life Insurance Companies.* By R. J. Saulnier. New York: National Bureau of Economic Research, 1950. xxii + 180 pp. 9". \$2.50.

The statistics on which the investigation was based were obtained in part from public sources, but mainly from returns made specially available by the insurance companies to the National

* It is particularly difficult to accept *both* of the following assumptions underlying the middle-class price index:

(a) Middle-class prices rose very much more steeply than working-class prices between 1938 and 1947 for several groups—notably food and miscellaneous goods (page 50).

(b) The middle-class index can be projected beyond 1947 by assuming each group to follow the working-class one (page 51).

1951]

Bureau of Economic Research in New York: they have enabled the author to make a fuller examination of the loans by insurance companies secured on urban properties than has hitherto been possible. The returns were furnished for much of the material by nearly all the companies, but for some of the subjects with which he wished to deal the author was content with information obtained from some of the companies, and when information was required about individual mortgages the companies provided it in respect of a sample. These limitations were necessary, and would not have affected any of the conclusions drawn from the statistics.

The book begins by giving an idea of the extent of the interest of the insurance companies in the particular type of investment, and estimates that in the various years from 1929 to 1948 between 14 per cent. and 19 per cent. of the total mortgage debt was due to insurance companies: in 1948 mortgages held by the companies exceeded \$10,000 million. From the point of view of the companies the percentage that their investments in urban mortgages bore to their total assets was about 15 per cent., but some companies do little or no investment of this kind, while, at the other end of the scale, about one-tenth of the companies had 40 per cent. of their assets so invested. Many companies also had investments in Urban Real Estate, some of which had arisen from foreclosed mortgages. The higher percentages of mortgages (40 per cent. and over) seem high, especially in America, where surrender values of most life assurances are guaranteed, so that there is a possibility of a "run on the bank"; such a possibility may seem unimportant, but it will be remembered that less than twenty years ago something like a "run" actually occurred and the law was temporarily relaxed—a hint of the danger of guaranteed surrender values on a generous scale, especially when a large proportion of the assets is invested in securities that are not easily realizable. Those companies which have a high proportion of their assets in mortgages may have granted such kinds of life assurance as minimize any risk there may be, or may consider that in such emergencies as might create a run, the so-called marketable securities might become so unsaleable that State intervention would be necessary in any event.

The author next deals with the legal framework of loans, and points out that apart from the laws relating to mortgages in general, the insurance companies are restricted as regards the mortgages they can take, and that a restriction enforced by the laws of a State in which a company does insurance business may apply not only to mortgages on property in that State but to mortgages in other States also. The limitations are not unreasonable, and it is unlikely that a well-managed concern would want to invest outside the prescribed limits. In New York, for instance, mortgages on single properties are limited to \$25,000, or 2 per cent. of the company's assets, whichever is greater, and, in aggregate, mortgages must not exceed 40 per cent. of assets. The proportion of the value that may be lent is limited by the State laws to 66⅔ per cent. (or even in some States to less than 50 per cent.), unless there is amortization within, say, 15 years. There are also limitations on the amount of real estate that may be held, which might be important if a company had a number of foreclosed mortgages.

The Insurance Companies use either a branch organization to obtain and manage their mortgage business or employ correspondents for that purpose, though both plans may be used. The type of security accepted and the distribution of the business geographically and according to the size of the loans is discussed in respect of a 1 per cent. sample of the mortgages of leading companies. The figures given do not call for comment here except to remark that many more mortgages were granted in 1925-9 and in 1940-6 than in the other quinquennia back to 1920. The loans on residential property are usually backed by insurance and fully amortized but, as one would expect, with loans on other property partial amortization is largely accepted. The average current rates of interest on urban mortgages held at the end of 1946 was 4.5 per cent. on dwellings and 4.2 per cent. on other property, and these rates seem satisfactory, but of course the rates of interest charged on new mortgages varied considerably, and there was an appreciable decline from the high rates obtainable in 1920 to 1924. Moreover, in order to see what these investments really produce, estimates must be made of the costs involved in granting the loans, collecting the interest, etc., and of any losses incurred through default and the realization of the security. The discussion of these points is perhaps the most interesting part of the book. Considerable detail is given in the tables in Appendices B and D showing the gross income, costs and net income, and the results may be summarized by saying that the companies with the smaller portfolios show the higher rates of expense, but this is partly due to the larger loans being accepted by the companies with large portfolios: these larger loans, however, carry lower rates of interest, and this tends to bring the net returns of the companies more nearly in line. It must be confessed that to anyone with United Kingdom experience of mortgages the costs appear high, and this is partly because of the practice in America of paying fees for securing mortgages,—a course which no prudent lender would adopt in the United Kingdom, though as, apparently, the practice is almost universal in the U.S.A., the objections that would occur to an investor in the United Kingdom may not apply. •The other expenses also seem high, so that the net return shown for

several companies appears insufficient, and one wonders whether there has been some exaggeration in the expenses attributed to the mortgages. There is an interesting chapter on the loan experience of the insurance companies, showing the mortgages properly conducted, the delinquent mortgages and the foreclosed real estate—there was a bad period of delinquency about 1934, and in consequence there was some decline in mortgages in the next few years owing to foreclosures and the transfer of loans to the owned real estate account, which was not greatly reduced by realizations until the early war years. The author says on page 82 that “the outstanding factor affecting foreclosure rates appears to have been the year of loan origination, with foreclosure rates highest on loans made in years of high real estate prices and construction activity and lowest on loans made under the opposite condition”. This is what anyone with experience of mortgages would expect, and if there were more violent fluctuations in values in the U.S.A. than in, say, the U.K., then, other things being equal, the U.S.A. mortgages would exhibit a higher rate of foreclosure than those in the U.K. It is also true, as the author remarks, that “loans, made in the trough of a depression are more likely to be repaid according to contract in the following period of rising income and property values”. It does not necessarily follow that a high rate of foreclosure means a loss, for the property may bring in a good income or may be realized at a good price but, so far as the experience investigated shows, there was an appreciable loss resulting from these foreclosed mortgages—a loss that further reduces the rate of interest realized on the investments.

The book is well arranged and well printed, and is valuable as giving a substantial account of urban mortgages in the U.S.A.; mortgagees in the U.K. will be interested to see how far the American statistics tally with their own impressions.

W. P. ELDERTON.

18.—*Economic Survey of Asia and the Far East*, 1949. New York: United Nations, 1950. xix + 485 pp. 9s. 22s. 6d.

The Economic Development of Latin America and its Principal Problems. New York: United Nations, 1950. 59 pp. 9s. 40 cents.

The three regional economic commissions set up by the Economic and Social Council of the United Nations—that for Europe set up in 1946 (E.C.E.), that for Asia and the Far East set up also in 1946 (E.C.A.F.E.), and that for Latin America set up in 1948 (E.C.L.A.)—are now issuing valuable publications on the economic problems of these regions. The work of the first of these is now becoming well known through its annual surveys, its quarterly bulletins and numerous committees, but that of the other two, though based on information, statistical or otherwise, much less adequate than that for Europe, is now yielding valuable results.

The first of the two volumes under review gives a remarkably full and exhaustive account of the economic situation during the year 1949, and of the factors underlying post-war development in each of the countries covered by this Commission, including Japan, which is not at present a member of E.C.A.F.E. The general picture is one of improvement throughout the year, marred however by a set-back in agricultural production in China. It is estimated that the region, with one-half of the world's population, provides less than one-third of its food production (about 35 per cent. before the war), and that its *per capita* consumption of food and durable goods is declining. It concludes that a rapid increase in the standard of living of the region is out of the question. “It would take all the presently available resources of the countries in the next five years to ensure at least maintenance of *per capita* production and consumption levels. Even this limited goal cannot be attained without the continuous and systematic efforts of the peoples and Governments of the region supported and encouraged by the active assistance of countries outside the region . . . and not least of the United Nations . . . and other international bodies”. The volume contains a large number of valuable statistical tables on all aspects of economic life in these countries and maps of the coal and iron reserves of the region.

The second volume is the first publication of E.C.L.A. Unlike the first volume, it does not contain an economic survey of the position in different countries, and no separate statistics are given of the countries in the region; it treats the area as a whole. In this short study of 60 pages Professor Prebisch, the author, points out that Latin America is now passing from the stage of producing food and raw materials for the great industrial countries to that of becoming industrialized. The situation is discussed, analytically, in relation to the terms of trade, the problems of dollar shortage, capital formation, and the limits of industrialization. The “core of the problem”, says the author, is the raising of the import coefficient of the U.S.A. (now only about 3 per cent. of its national income). If this coefficient is not raised, “Latin America will be compelled to divert its purchases from the United States to those countries which provide the exchange to pay for them”, a solution which, the author says, is “very dubious, since it often means the purchase of more expensive or unsuitable goods”.

J. W. NIXON.

1951]

19.—*The Socialized Agriculture of the U.S.S.R.: Plans and Performance.* By Naum Jasny. California: Stanford University Press, 1949. xv + 837 pp. 9". \$7.50.

This massive publication of the Food Research Institute, Stanford University, embodies an exhaustive analysis of the development of Russian agriculture since the Revolution so far as it can be inferred from official and other Russian publications. As the author remarks, "The book is long and ponderous, but it could not be otherwise in view of the size and complexity of the subject, the limitations of the available information and the intricacies of Soviet statistics". There are exceptional difficulties in the way of a critical examination of this sort in Russia, primarily because Soviet methods do not favour the publication of statements which directly or indirectly suggest any lack of success in the methods prescribed by the Government. At one time Soviet statistics were collected and published as in other countries on a "neutral" basis as statements of fact, but after about 1929-30 they were replaced by "Marxian" or "class statistics" which were definitely intended to help in "socialist construction"; indeed one of their most important roles was to demonstrate the great successes of Soviet economy. In effect this has led to the withholding of information, to the publication of selected data, and to their presentation in a misleading way. Another complication in the case of agricultural figures has arisen from the fact that a break with the traditional method of crop estimating was made in 1933 whereby the customary estimate of the yield actually harvested was replaced by what is called the "biological yield"—that is, an estimate based on small sample areas of what the crop might be expected to yield without allowing for the risks inherent in harvesting and storing. This method, which was supposed to encourage good harvesting, always gave a higher yield, and was therefore useful in showing favourable results. It had also special administrative advantages.

The sifting and analysis of these difficult figures is the task undertaken in the present volume. Precise conclusions are impossible, but it offers a detailed picture of value to any student of Russian affairs, and one which is probably not available elsewhere.

Some broad general deductions may be drawn. It is evident that socialized farming was introduced and developed in the U.S.S.R. under such adverse conditions in the face of peasant opposition that anything like the anticipated results was impossible. However, progress was gradually made after the first set-back, and by 1939 output had possibly recovered to the level ruling before collectivization, grain and industrial crops being higher and animals products lower. Then the war intervened, agriculture suffered greatly, and it is questionable whether subsequent recovery will enable the pre-war output level to be reached by 1950.

The socialization which was started in 1926 or thereabouts contemplated two main forms: the large state farms operated by hired labour, and the collective farms, which were in principle a combination of peasant holdings, worked in common, though there are several types. Great hopes were entertained of the state farms, for which the most extravagant claims were made, but lack of experience and mismanagement made them unsuccessful; and owing to the employment of an army of technicians and administrative personnel the cost of production was very high. Ultimately these state farms, which were expected to be the mainstay of agricultural production, had to be relegated to a minor role, and only about 9 per cent. of the arable land is now under direct state management.

The collective farms account for practically all the remaining land, and though they are far from representing the communist ideal, they have had perforce to be accepted as the permanent basis of socialized agriculture, not because of their ability to produce abundantly or cheaply, but because there is not much alternative, and because the Government is able to extract from them a larger share of the total produce than could be obtained from individual producers. The heavy flow of farm goods which was expected to result from the increased output of these collective farms failed to materialize, and the needs of the workers in towns and factories had in fact to be made up by increased Government collections and increased pressure on the peasants.

The failure of the ideal is especially noticeable in the necessity for allowing the members of the collective farms to have their own tiny holdings and special markets where their surplus output can be sold at free prices direct to consumers. This involves extreme price differences from place to place and frequently from day to day, as well as an inordinate waste of time both to sellers and buyers, but the peasants by selling some produce at exorbitant prices get some compensation for delivering another portion to the Government at exceptionally low prices. According to official computations these markets accounted for nearly 25 per cent. of the total food turnover in 1938, and this proportion is believed to have increased since then.

Another anticipation which seems to have missed fire is that the merging of the small scale peasant farms into large socialized units would enable the necessary work to be done with fewer workers. It is very uncertain how far this is the case, particularly for livestock.

On the whole, although optimistic statements as to the success achieved are made officially with glowing versions of the advantages of collective farms as compared with the old peasant

holdings, progress, such as it is, seems to have been exceedingly slow, though no doubt the modern undertakings have benefited from improved education and medical facilities. The major persisting difficulty seems to arise from the state appropriation of a large part of the collective output at inadequate prices, so that the effective wages of the workers are extremely low.

R. J. THOMPSON.

20.—*A Social Survey of Singapore, 1947.* Singapore: Department of Social Affairs. viii + 165 pp. Table, map. 8½".

This "preliminary study of some aspects of social conditions in the municipal area of Singapore" was carried out by the Social Welfare Department of the Colony in December, 1947. The department was a new one, set up to deal with certain "aspects of want, delinquency and of leisure"; but it soon became aware that in order to deal with these problems it required information on social conditions in Singapore, and this is the first inquiry made to ascertain some of the facts.

The survey was planned by a committee set up by the department, but the actual interviewing was undertaken by local students. The report gives a detailed and admirable description of the survey design with copies of the interview schedule and the fieldworker's instructions; in these respects it is superior to reports on some other inquiries seen by the reviewer. The sample design was a simple form of cluster sampling, involving only one stage, with the sampling units selected at fixed intervals. The selection of sampling units was relatively simple, because lists of "houses" prepared for the 1947 population census were available. There were separate lists for each of the fifty-four census wards into which the Singapore municipality was divided; "houses" were selected by taking every thirtieth, beginning at a random point for each ward. The selected houses numbered 1,883, and all households living in each were interviewed, a separate schedule being completed for each household. It was possible to interview all the households in the majority of the selected houses; the exception being 100 cases where the address could not be located, and a similar number where some or all the individual households either could not be contacted, or refused an interview. The first group constitute a problem not met with to the same extent in Western countries, where the population is less mobile. In fact, the census definition of a "house" was very broad, including as separate entries a wide range of accommodation varying from a space under a staircase to a large block of artisan quarters, and covering also many huts and other dwellings of a temporary nature.

It would appear that the remaining 1,650-odd "houses" yielded 4,965 households with 19,380 persons—the population of the municipal area of Singapore was just under 700,000. It is at this point that a criticism may be mentioned. The report analyses the results in terms of households or of persons, although the sampling units were "houses". This was obviously of more practical value, especially as the definition of a "house" was partly determined by purposes of convenience in administering the census. However, the number of households within a sampling unit is subject to wide variation—there was on an average of three—and furthermore there is a likelihood that households within the same cluster will have some similar characteristics. The report does point out that it is not possible to give estimates of the sampling errors unless account is taken of these facts, but goes on to say that the facilities available did not enable this to be done. It is perhaps rather unfortunate therefore that tables were not included showing the relation between certain of the main characteristics and the type of "house".

The results described in the report are concerned with certain demographic details of the sample, housing, education of children and of adults, and the relations of immigrants with their native countries. The actual interview included a number of other subjects not covered by the report, but apparently included to give preliminary material for planning future inquiries. The interview dealt with a wide variety of subjects, but did not cover household or personal income for reasons explained in the report, nor expenditure.

The chapters dealing with the demographic results proceed along orthodox lines, but reading the chapter on housing one particularly notices the different type of problem encountered, which naturally influenced the way in which the subject of overcrowding was handled. In Great Britain problems of definition arise in distinguishing different kinds of houses and flats. But in this survey the distinction had to be made between those in accommodation consisting of one or more rooms, or cubicles or "spaces". The last group in particular must have given the interviewers over it was in itself a fairly important group, covering 15 per cent. of the households in the sample. The category covered households whose sole habitation consisted of sleeping accommodation which might not even be as permanent as bunks in passage-ways, but might be places used for sleeping, which during the day-time were used for other purposes such as shops, factories or offices.

Two other subjects covered by the report are also worth separate mention. An analysis of

1951]

the numbers of children who were receiving education was of some importance in an area where there was no universal free education. The report analyses the kind of families whose children attended school, and incidentally confirms the greater value placed on the education of boys as compared with girls. The social survey technique has also enabled an intensive analysis to be made of the strength of the ties which immigrants maintain with their native country, in terms of the number of visits made, the duration of time spent in the Colony, and whether remittances were sent by them to their homeland. Of the three main races, the Chinese, Indians and Malaysians, it appeared that the Indians retained most interest and the Malaysians least in their country of origin.
W. F. F. KEMSLEY.

21.—Other New Publications.

Accounting (Part I). By Stanley W. Roland and Brian Magee. 5th ed. London: Gee & Co., 1949. xi + 39 pp. 8½". 15s.

This textbook is now revised to cover changes in accounting practice resulting from amendments in the Companies Act. Intended for accountancy students, the contents are mostly outside the statistician's specific field, but students and research workers handling data drawn from financial accounts will find interest in the description of the ascertainment of profit and the guidance in the interpretation of balance sheets.

The Measurement of Profit. By F. Sewell Bray. London: Geoffrey Cumberlege, 1949. viii + 80 pp. 8½". 10s. 6d.

The concept of profit is studied by the economist as well as by the accountant but, as Mr. Richard Stone points out in his preface to this book, there has hitherto been little discussion of the subject between the two professions. Recently Mr. Bray has continued and completed an inquiry into the measurement of profit first conceived by the Research Committee of the Society of Incorporated Accountants. This book gives the results and suggests new forms of accounting to reveal the periodical incoming capital resources of an enterprise and to show how they are being used.

Overhead Costs. Some Essays on Economic Analysis. By W. Arthur Lewis. London: Allen & Unwin, 1949. 200 pp. 8½". 15s.

The subjects treated in these essays are both more varied and of more general interest than the title suggests, and the book provides useful background reading at present when experiments in the nationalization of large-scale enterprises are being made. The opening essay on fixed costs surveys the problems arising out of overhead costs in general, and studies in particular the competition between road and rail transport. Other essays deal with the principles of the two-part tariff as used in electricity, gas and telephone supply; the economics of loyalty or goodwill; the interrelation of shipping freights; competition in retail trade; monopoly and the law; and, finally, the administration of socialist enterprise. Of the seven, only that on shipping freights is specifically statistical.

The Use and Abuse of Statistics. By F. R. E. Mauldon. Third edition. Crawley, Western Australia: The University Bookshop, 1949. iv, 129 pp. 8½". 8s. 6d.

Students in Australia should find this a useful introduction to statistics, since it uses Australian official statistics as a basis for simple explanations of statistical terms and methods. Professor Mauldon hopes to help in creating a wider appreciation of the services performed by the official Statistical Bureaux, and the informal style of this elementary manual should commend it to the lay public of Australia, where text-books for beginners in statistics are not as numerous as in Britain or the U.S.A.

Labour. By P. Sargent Florence. Hutchinson's University Library No. 25. London: Hutchinson, 1949. 230 pp. 7¼". 7s. 6d.

The facts on which this book is based are drawn from British labour statistics but the practical problems discussed by Professor Sargent Florence confront the whole of western civilization to-day. The intelligent general reader to whom the book is addressed will find the manual informative, thorough and well-arranged. Labour resources and their utilization, conditions of employment, the incidence and prevention of unemployment are discussed in Parts I-III, while the final section deals with the direction of labour policy to secure industrial efficiency, maximum production and full employment.

STATISTICAL NOTES

(1) BRITISH OFFICIAL STATISTICS

The interim index of retail prices compiled by the Ministry of Labour and National Service, which had been 113 or 114 from January to September, 1950, rose to 115 in October, 116 in November and December, and 117 in January, 1951. The rise in October was mainly due to advances in the prices of fish and eggs, many articles of clothing and textiles, gas and electricity and shoe repairs. The further rise in November was due to price increases for coal, carpets, various items of clothing and some household appliances. The rise in January affected some food items, clothing, and some household and miscellaneous goods. The detailed figures for September to January were as follows:

(Prices at June 17th, 1947 = 100)

Date	Food	Rent and Rates	Clothing	Fuel and Light	House- hold Durable Goods	Miscel- laneous Goods	Services	Drink and Tobacco	Total
Weights:	348	88	97	65	71	35	79	217	1,000
Sept. 12th, 1950	122.1	101.4	120.7	116.8	113.3	112.9	109.6	103.9	114
Oct. 17th, "	124.6	101.4	121.9	117.8	114.1	112.7	110.7	103.9	115
Nov. 14th, "	124.7	101.4	123.2	119.9	116.2	113.2	110.9	104.0	116
Dec. 12th, "	125.4	101.5	124.3	121.9	117.0	113.3	111.1	104.1	116
Jan. 16th, 1951	126.9	101.5	126.0	122.3	120.5	114.3	112.9	104.1	117

In publishing the figures, the Ministry of Labour states that they are in the form in which they are used in the procedure adopted for calculating the index for all the groups combined, i.e. to the nearest first place of decimals. The decimals are shown in order that, if desired, calculations can be made of the effect of combining particular groups and excluding others. The information available as to price changes, however, is such that no precise significance can be attached to the decimals, and for any other purposes, therefore, the figures should be used to the nearest whole number.

The Ministry of Labour index of weekly wage rates which had been unchanged at 110 (June, 1947 = 100) from January to September, 1950, rose to 111 in October, 113 in November, 114 in December and 115 in January. At the end of January the index stood at 114 for men, 117 for women and 119 for juveniles. The principal increases in the four months affected workers in agriculture, coalmining, the cotton and wool textile industries, iron and steel, engineering, shipbuilding, goods and passenger transport and boot and shoe manufacture.

After two years' experience of the periodical counts of the number of persons covered by the National Insurance schemes the Ministry of Labour has found it necessary to revise some of its past estimates of the working population. The following are the revised estimates of the total working population and of the number in civil employment at recent dates compared with mid-1948, when the figures based on the Insurance schemes first became available.

	Total Working Population			(Thousands) Numbers in Civil Employment		
	Males	Females	Total	Males	Females	Total
Mid - 1948	15,810	7,094	22,904	14,698	6,986	21,684
Nov., 1950	15,927	7,362	23,289	15,001	7,241	22,242
Dec., "	15,921	7,304	23,225	14,964	7,181	22,145

The fall of 64,000 between November and December in the total working population was largely seasonal and was about the same as the fall in the corresponding months of 1949. A decline in the numbers in civil employment occurred in transport, many of the manufacturing industries and in building. There was a small increase in coal mining.

1951]

The level of unemployment showed a rise in October then fell slightly, but rose again in January. The figures are analysed below.

Number of Unemployed Persons on the Registers of the Employment Exchanges of the Ministry of Labour and National Service

Date	Men and Boys	Women and Girls	Total
Sept. 11th, 1950	196,511	87,324	283,835
Oct. 16th, "	206,083	97,980	304,063
Nov. 13th, "	201,380	100,691	302,071
Dec. 11th, "	205,888	95,928	301,816
Jan. 15th, 1951	230,864	102,707	333,571

The figures do not include registered severely disabled persons who are unlikely to obtain work other than under special conditions.

It is estimated that the number of unemployed persons on the Registers at January 15th represented 1·6 per cent. of the total number of employees insured under the National Insurance schemes. The percentages in the various Regions ranged from 0·5 in the Midlands and 0·7 in the North Midlands to 2·9 in the Northern Region, 3·3 in Scotland and 3·6 in Wales.

The number of insured persons absent from work owing to sickness, including self-employed as well as employed, followed a seasonal course. It rose from 831,700 in September to 879,000 in October and 900,300 in November. It then fell to 860,000 in December, but rose to 1,426,000 in January, mainly as a result of the influenza epidemic. In January, 1950, the number was 978,500. The number of employed persons absent owing to industrial injuries was 62,800 in September, 64,100 in October, 63,200 in November, 57,500 in December and 62,000 in January. All these figures were slightly lower than in September to December, 1949, and January, 1950.

The Ministry of Labour and National Service has issued a revised edition (August, 1950) of *Guides to Official Sources, No. 1, Labour Statistics* (H.M.S.O., 1s. 3d.), a booklet which, since its original publication in 1948, has proved its worth to teachers and students, as well as to research workers. This guide now takes account of the changes in employment statistics resulting from recent legislation. Whether describing labour statistics or indicating sources, the text is clear, authoritative and comprehensive. Notes on the use of each group of statistics leave no excuse for misinterpretation of published tables, and if every user were to take this handbook as an essential tool, much time and trouble would be saved. While the primary object is to give guidance concerning data on employment, wages, retail prices, etc., collected by the Ministry of Labour and National Service, sources of international statistics are indicated in one of the appendices. Among the other matter included in appendices are specimen forms used in collecting particulars of employment, earnings and hours of work.

The 92nd Report of the Commissioners of Inland Revenue (Report for the year ended March 31st, 1949. H.M.S.O., Cmd. 8052, 3s. 6d.) has been greatly expanded, some of the additional tables being published for the first time and some being revivals of tables which lapsed with the outbreak of war. The year under review marked the centenary of the Board, and the statistical section of the Report opens with five tables and a similar number of charts illustrating the progress of the main duties during the past 100 years. The most interesting of the other new or revived tables are those showing trading profits in 38 trade groups for the year of assessment 1948-49 (broadly speaking, the profits of 1947), with comparative figures for 1937-38, 1938-39 and 1939-40 (profits of 1936, 1937 and 1938); an analysis, also by trade groups, of total remuneration and tax deducted under the P.A.Y.E. system in 1948-49; a classification of personal incomes by range of income and family circumstances (i.e., marital status, number of children, etc.); and a classification of estates liable to Estate Duty, by type of property within ranges of net capital value. The Report draws attention to the wealth of information on income and capital which is contained in the records of the Department. Much of this is only available locally and could not be collected centrally without undue labour and expense, but it is intended to publish the maximum amount of information which can reasonably be made available. A

Census of Incomes, on a sample basis, is to be taken from Departmental records in respect of the year 1949-50, and from the results of this Census will be published information on the distribution of personal incomes in income ranges by type of income, by family circumstances, and by region. The last such census related to the year 1937-38. Other information promised for future Reports includes statistics relating to the financial operations of industry, showing by trade groups the proportion of total receipts disbursed for materials, wages and salaries, other costs and depreciation, and the division of net profits between tax, dividends and sums placed to reserve. It is also intended to revive the analysis of the Estate Duty statistics by age and sex of the deceased.

The *Report of the Interdepartmental Committee on Social and Economic Research* (H.M.S.O., Cmd. 8091, December, 1950, price 6d.) carries the account of the work of this Committee to July, 1950. In reviewing the organization for social and economic research in Government Departments *vis-a-vis* the universities, it rightly draws attention to that storehouse of information on current research, the Register of Research in the Social Sciences. The committee believes that as its work becomes more widely known there will be a considerable growth of its function as a clearing house between official and non-official interests. As an example of this the report cites the project for research into social selection and differentiation located at the London School of Economics, backed by the Nuffield Foundation, and of interest to the Ministry of Labour and National Service and the Population Investigation Committee.

The second section of the report deals with the Committee's work in surveying material in the hands of Government Departments which may have a value for research over a wider field. During the period under review the Committee have been engaged on the material held by the Ministry of Education and the Board of Trade. Other main headings of the report deal with the Guides to Official Sources (where booklets on the Board of Trade and the General Register Office statistics are noted as in preparation), Statistical Tabulations and the Presentation of Statistics for Conurbations.

(2) OTHER STATISTICS.

The papers presented at the 26th session of the International Statistical Institute are published in the *Bulletin de l'Institut International de Statistique*, Tome XXXII, 2e livraison, Berne, 1950, a volume of nearly 500 pages. They cover a wide range of statistical matters such as one would expect at an international conference. The fifty-six papers given in this volume, together with a further eight in various issues of the *Revue de l'Institut International de Statistique*, are divided into seven main groups:

	Number of Papers in this Volume
I. Training of Statisticians	2
II. Applications of Statistical Methods in Industry	11
III. Recent Developments in Various Fields	9
IV. Statistical Sampling	8
V. Statistical Methodology	5
VI. Demographic Statistics	13
VII. Economic Statistics	8

It is interesting to note that the second group has been issued as a reprint and can presumably be obtained from the Institute's office at The Hague.

To give a list of all these papers would press too heavily on the space available in the *Journal*. It would also be invidious to mention any selection of papers since this would do no more than represent the preferences of the writer of this note. Clearly, however, the volume is the kind of statistical "feast" not lightly to be ignored by practising statisticians and students who wish to keep abreast of current developments in the statistical world at large.

The report of the biennial analysis of clerical salaries held in 1950, *Clerical Salaries Analysis*, 1950 (Office Management Association, price 21s.) has now been published. The tables are arranged in four main sections: A, All areas and all industries; B, Area tables; C, Industry tables; D, Government services, banking and certain nationalized industries. The Job Grading Schedule of the Association is given in an Appendix. Extensive use is made of the median and quartiles, together with the quartile deviation expressed as a percentage of the median. The tables are well laid out and these surveys provide a well documented continuing source of information in this field.

1951]

CURRENT NOTES

A new year book, *The Scope Year Book of Industry, Trade, and Finance*, 1950 (London, Scope Books, 1950, 645 pp., 45s.), subtitled "An Encyclopaedic Reference Book for Business and the Professions", has been compiled by a panel of economists and statisticians, and takes its place with established classics such as *Whitaker's Almanac*, *The Statesman's Year Book*, and of more recent origin, the *Economist Diary*. *The Scope Year Book* is more specific in its outlook than either *Whitaker* or *The Statesman's Year Book*, and in practice may well prove complementary to the *Economist Diary*.

- The selection of information for a desk reference book is largely a matter of personal taste as to the relative importance of topics, and the following summary of its contents may therefore be of some assistance in indicating the range of this one. The book is divided into four sections: (I) A review of the British economy in 1949; (II) Facts for reference; (III) Statistical section; (IV) Index. In the first section are more than a dozen surveys of the main divisions of the national economy, together with a review of the year 1949 and a diary of events. The second section is a collection of facts and personal details for public and private authorities in the United Kingdom and in overseas countries and for international organizations. The outstanding features in Section III are the well-drawn graphs and diagrams which illustrate the tabulated statistics, and the bibliography of current statistical sources. An appendix is provided giving a selected list of recent official papers classified according to the subject matter. The thirty-page index which forms the last section does much to facilitate reference.

The practical statistician will be glad to find a place on his bookshelves for the new periodical, *The Incorporated Statistician*, the first number of which has recently been published. This is the Journal of the Association of Incorporated Statisticians Limited and primarily seeks to serve the interests of the practicing statistician. The first number opens with a message from Lord Beveridge, the President of the Association, which is followed by contributions from Dr. Dudding, Mr. Wharton and Mr. Morrell. The Journal is published by the Association and can be obtained from 54, New Broad Street, E.C. 2, at a cost of 5s. We extend our good wishes to this new venture and trust that it will achieve the success it so fully deserves.

OBITUARY

LESLIE JOHN COMRIE

The death occurred in December last of Dr. L. J. Comrie, F.R.S., Director of Scientific Computing Service, Ltd., and until two years ago a Fellow of the Society. With his death the scientific world loses a recognized pioneer in mechanical computing and the leading expert on mathematical tables.

Born at Pukekohe, New Zealand, in 1893, he first came to this country as a member of the New Zealand Expeditionary Force which he had joined as a young graduate in Chemistry of the University of New Zealand (Sir George Grey Scholar, 1915). He was wounded in action and lost a leg.

It was on Armistice Day (as he would often recall) that, as a New Zealand Expeditionary Force Scholar at University College, London, he received his first instruction in computing on a Brunsviga calculating machine from the late Professor Karl Pearson. Later, as Isaac Newton Student, he took his Ph.D. in Astronomy at Cambridge. In 1923-25, while on the faculty of two American Universities (Swarthmore College, Philadelphia, and Northwestern University, Chicago) he introduced computing as part of the curriculum. During the eleven years (1925-36) of his connection with H.M. Nautical Almanac Office at the Royal Naval College, Greenwich, as Deputy-Superintendent (1926-30) and later as Superintendent (1930-36), he was mainly concerned with the preparation of the Nautical Almanac, but his keen interest in other astronomical matters was reflected in his acting as Secretary of the International Astronomical Union Commission on Ephemerides (1932-8) and his Honorary Membership of the New Zealand Astronomical Society (1933). During this time he evolved new and far-reaching methods of mechanical computing. Outstanding among these are his original ideas of using Hollerith punched card machinery and his discovery that the 6-register National accounting machine can be adapted to perform mechanically the operation of "differencing" and "finite integration." His ingenious methods of "subtabulation," based on these operations, completely changed procedures of mathematical tabulation and the machine has been installed and his methods adopted by many organisations. He gave an account of this work when in 1936 he read a paper to the Industrial and Agricultural Research Section of the Society.

Comrie published many other papers, some astronomical, but most on various aspects of computational science, and all characteristic of his lucid talent of exposition. The numerous lectures he gave also bear witness of this. Notably among these are the Newmarch Lectures at University College (1933), but he would be equally enthusiastic and successful keeping a hall full of school boys spellbound with his computing tricks, making them roar with laughter through showing up their headmaster's inability to do simple sums!

He left the Nautical Almanac Office in 1936 and in 1938 founded Scientific Computing Service, Ltd., a firm of scientific consultants on computational projects and mathematical tables, also concerned with the planning and execution of scientific calculations, particularly those where mechanical computation and mass production methods may be employed. Comrie devoted all his knowledge and energy to the development of this organization which later in the war was charged with large-scale, high-priority computational tasks for Service Departments and others directly concerned with the war effort. At the head of about 30 young members of his staff he gave a shining example of industry and accuracy. On one occasion, for instance, when in the completion of urgently needed "bombing tables" for the United States Air Force in England, he himself volunteered to do the "night-shift" to run the National machine, and at 9 a.m. he proudly produced his work to the morning arrival of staff with the words "not bad for the old man!"

Comrie once described himself as a "lover of tables", and, indeed, his encyclopaedic knowledge of mathematical tables, their history and errors, their computation and interpolation, his masterly treatment of tabular typography and lay-out go far beyond the achievements of a "connoisseur". As the Secretary of the British Association Mathematical Tables Committee (1929-36) he took the initiative in the production of many tables, notably those of Bessel functions, and when later this Committee was replaced by one sponsored by the Royal Society he naturally became one of its members. He took a lively interest in the editorial work of *Mathematical Tables and Aids to Computations*, a quarterly sponsored by the National Research Council of America, and his correspondence with its editor, Professor R. C. Archibald, was, at times, at the rate of a letter a day.

Comrie has had a hand in the production of many tables. The well-known "Barlow's Tables" were completely revised by him, so were Chambers' 7-figure tables, which he completely modernized

1951]

Obituary

and converted to a most valuable set of 6-figure tables. His 4-figure tables of elementary functions (jointly produced with L. M. Milne-Thomson) is one of the most useful books of tables for low-figure accuracy. But there are many other works connected with tables in which he had a helping hand—notable is the *Index of Mathematical Tables* by Fletcher Miller and Rosenhead, a most useful book of reference.

In an age that will see an increased use of electronic calculating machines Comrie will be remembered as the veteran pioneer who always maintained that before special machines were constructed there should be a thorough investigation of the possibilities of ordinary commercial calculating machines. No more convincing case could have been made for this thesis than by the disciplined economy of the methods he has himself developed, used and propagated. His life work found deserved recognition when shortly before his death he was elected a Fellow of the Royal Society.

- Those who knew Comrie personally could not fail to be impressed by his forceful personality—
- a tower of strength unswervingly pursuing the tasks he had set himself, as those who have tried
- in vain to “change his mind” will be able to testify. His life was full of work and toil and his death at the comparatively young age of 57 was no doubt largely due to his sacrifices and exertions.

H. O. HARTLEY.

STATISTICAL AND ECONOMIC ARTICLES IN RECENT PERIODICALS

UNITED KINGDOM—

Advancement of Science—

December 1950—The critical importance of higher technological education in relation to productivity: *Sir Ewart Smith*. Output problems in house building: *J. Bronowski*.

Annals of Eugenics—

October 1950—Rhesus type D^u: *P. H. Renton* and *F. Stratton*. Measurements of infants at birth: *A. Low*. Congenital colour blindness associated with otosclerosis: *A. G. Macgregor* and *R. Harrison*. The combination of blood groups in a sample of 475 people in a London hospital: *D. Bertinshaw*, *S. D. Lawler*, *H. A. Holt*, *B. H. Kirman* and *R. R. Race*. Data for the study of linkage in man: red hair and the ABO locus: *L. S. Penrose*. Taste deficiency for phenylthiourea in African negroes and Chinese: *N. A. Barnicot*. The inheritance of the Lutheran blood groups in forty-seven English families: *S. D. Lawler*. Inheritance of the Rh blood groups: 150 families tested with anti-C-c-C^w-D-E and anti-e: *S. D. Lawler*, *D. Bertinshaw*, *R. Sanger* and *R. R. Race*. Blood-group frequencies in a mother and infant sample of the Australian population: *L. M. Bryce*, *R. Jakobowicz*, *N. McArthur* and *L. S. Penrose*. The fractional replication of factorial experiments—a correction: *D. J. Finney*.

British Journal of Social Medicine—

July 1950—The total lung volume and its subdivisions. III: *A. G. W. Whitfield*, *J. A. H. Waterhouse* and *W. M. Arnott*. The care of the chronic sick: *C. R. Lowe* and *T. McKeown*. A study of respiratory tuberculosis in relation to housing conditions in Edinburgh: *I. L. Stein*.

British Journal of Sociology—

September 1950—Cubic proportion in election results: *M. G. Kendall* and *A. Stuart*. Voting behaviour in a Lancashire constituency: *A. H. Birch* and *P. Campbell*. The structure of the Danish intelligentsia: *T. Geiger*. Patterns in recent social research: *P. Sargant Florence*.

Economica—

August 1950—Uniform cost accounting—a survey. Part I: *D. Solomons*. Notes on resale price maintenance: *B. S. Yamey*. Notes on the maximization process in company administration: *G. F. Thirlby*. Mechanical models in economic dynamics: *A. W. Phillips*. The European Payments Union: *R. F. Kahn*. On a theory of the trade cycle: *A. D. Knox*.

Economic Journal—

September 1950—Economic progress, retrospect and prospect: *G. C. Allen*. The structure of the Western German monetary system: *H. J. Abs*. The distribution of earnings and of individual output: *A. D. Roy*. The unity of political and economic science: *D. Black*. Empirical research and the marginal analysis: *P. Wiles*. The sterling balances of the sterling area, 1939-49: *H. A. Shannon*.

Eugenics Review—

October 1950—The problems of quantity and quality in the British population: *R. C. K. Ensor*. The fate of national intelligence: test of a thirteen-year prediction: *R. B. Cattell*. Our average age: *Sir C. Arden-Close*.

Incorporated Statistician—

Vol. I, No. 1, July 1950—Statistical methods as industrial tools—"Quality control": *B. P. Dudding*. The organization of a statistical department: *A. S. Wharton*. The estimation of age-standardized rates by sampling methods: *A. J. H. Morrell*.

1951]

Institute of Actuaries, Journal—

Vol. LXXVI, Part II, No. 343—The first centenary of J.I.A. The valuation of sickness benefits for non-standard and standard periods: *J. C. S. Hymans* and *R. C. B. Lane*. The trend of mortality from tuberculosis: *R. H. Daw*. On the coefficients in the expansion of e^x and e^{-x} : *R. E. Beard*.

Lloyds Bank Review—

October 1950—The Australian economy, 1950: *Sir D. Copland*. Devaluation one year after: *T. W. Kent*. Wanted: American capital exports: *W. Manning Dacey*.

London and Cambridge Economic Service Bulletin—

• November 1950—Some aspects of transport policy to-day: *C. F. Carter*, *A. R. Prest* and *A. D. Roy*. The upward trend of prices: *R. G. D. Allen*. Comparison of monthly and annual index numbers: *A. A. Adams* and *W. B. Reddaway*. Building and civil engineering in the 1st half of 1950: *I. Bowen*. Wage rates and earnings: *A. L. Bowley*. World commodity survey: *C. F. Carter*.

Manchester Statistical Society, Transactions—

Session 1949-50—Sizes of factories and firms in the cotton industry: *R. Robson*. The monopoly question: *W. Hagenbuch*. The growth of world industry: *J. Jewkes*. Problems in county planning: *G. W. Sutton Brown*. An integrated transport system: *Sir C. Hurcomb*.

Oxford Economic Papers—

Vol. 2, No. 2, June, 1950—Some aspects of competition in retail trade: *P. W. S. Andrews*. The equalizing effects of the death duties: *G. Z. Fijakowski-Bereday*. Productivity and the business man: *P. W. S. Andrews* and *E. Brunner*. The course of wage-rates in five countries, 1860-1939: *E. H. Phelps Brown*.

Oxford University Institute of Statistics, Bulletin—

July and August 1950—Post-war wages policy in Norway: *J. Inman*. The development of wages policy in the Netherlands: *P. S. Pels*. Wages policy and full employment in Britain: *A. Flanders*.

September 1950—Personal savings through institutional channels (1937-49): *E. Preston*. The national income: second quarter of 1950: *D. Seers*.

October 1950—The levelling of incomes: *D. Seers*. Problems of Western unification: *T. Balogh*.

November 1950—Juvenile labour in Oxford: *R. Godson*. E.P.U. and the future of sterling policy: *J. A. Sargent*. A note on defence expenditure: *K. M. Langley*.

Population Studies—

June 1950—The future growth of the population of South Africa and its probable age distribution: *L. T. Badenhorst*. The growth of Canadian population: *N. Keyfitz*. A note on mortality in Jamaica: *G. W. Roberts*. Development of birth registration and birth statistics in the United States: *S. Shapiro*. The sample census of population in Poland, 1949: *S. Szulc*. Marital status and family size among matriculated persons in Sweden: *S. Moberg*. September 1950—Mortality in England and Wales from 1848 to 1947: *W. P. D. Logan*. Adequacy of existing census statistics for basic demography research: *J. D. Durand*. The decline of intelligence in New Zealand: *B. M. Giles-Bernardelli*. Pre-war and post-war trends in manpower of European countries: *G. Frumkin*. A sampling census in the Sudan: *C. H. Harvie*.

Review of Economic Studies—

Vol. XVII (3), No. 44—Degrees of competitive speculation: *J. E. Meade*. The theory of consumer monopoly: *S. Weintraub*. Investment policy in a nationalized industry: *M. F. Scott*. The community indifference map: a construction: *W. J. Baumol*. The invariant multiplier: *R. Eisner*. Inflation, deflation and employment in Italy: *E. S. Simpson*.

INDIA —

Calcutta Statistical Association, Bulletin—

July 1950—Note on the revision of All-India Wholesale Price Index, I: *A. N. A.* Note on the revision of All-India Wholesale Price Index, II: *H. Sinha.* Indian national sample survey: *H. K. Nandi.* A multistage stochastic model for natural fields: *B. Ghosh.*

Sankhyā—

September 1950—Why statistics?: *P. C. Mahalanobis.* Statistical inference applied to classificatory problems: *C. R. Rao.* A note on the distribution of $D^2_{p+q} - D^2_p$ and some computational aspects of D^2 statistic and discriminant function: *C. R. Rao.* Assumptions underlying the use of the tetrachoric correlation coefficient: *S. Vaswani.* Some suggestions regarding the Indian census questionnaire: *P. Mukherjee.*

UNION OF SOUTH AFRICA—

South African Journal of Economics—

September 1950—Cost accounting and business administration: *O. P. F. Horwood.* Dollar capital outflow in the South African balance of payments: *F. D. Holzman.*

UNITED STATES—

American Academy of Political and Social Science, Annals—

September 1950—Moscow's European satellites (whole number).

November 1950—Toward family stability (whole number).

American Economic Review—

September 1950—The problem of economic instability: a committee report. The supply function for agricultural products: *D. G. Johnson.* Consumption and investment propensities: *T-C. Liu* and *C-G. Chang.* Federalism and fiscal equity: *J. M. Buchanan.*

American Statistical Association, Journal—

September 1950—Pitfalls in population forecasts and projections: *H. F. Dorn.* The population of the world in the year 2000: *F. W. Notestein.* Population and resources: *J. S. Davis.* Controlled selection—a technique in probability sampling: *R. Goodman* and *L. Kish.* A technique for analyzing some factors affecting the incidence of syphilis: *B. G. Greenberg, J. J. Wright* and *C. G. Sheps.* Labor-force participation and employment opportunities for women: *N. L. Belloc.* Estimating parameters of Pearson type III populations from truncated samples: *A. C. Cohen, Jr.* Response errors in census research: *E. S. Marks* and *W. P. Mauldin.* A note on the derivation of income estimates by source of income of persons making less than \$500 per annum, 1944-1948: *U. H. Weil.* Estimating precision of measuring instruments: *H. Fairfield Smith.* Horatio Milo Pollock, 1868-1950: *B. Malzberg.*

Annals of Mathematical Statistics—

June 1950—The identification of structural characteristics: *T. C. Koopmans* and *O. Reiersol.* Some problems in minimax point estimation: *J. L. Hodges, Jr.,* and *E. L. Lehmann.* The theory of probability distributions of points on a lattice: *P. V. K. Iyer.* Minimax estimates of the mean of a normal distribution with known variance: *J. Wolfowitz.* Asymptotic properties of the Wald-Wolfowitz test of randomness: *G. E. Noether.* The distribution of the number of exceedances: *E. J. Gumbel* and *H. Von Schelling.* On the asymptotic distribution of the sum of powers of unit frequency differences: *B. F. Kimball.* Effect of linear truncation on a multinormal population: *Z. W. Birnbaum.* Extension of a theorem of Blackwell: *E. W. Barankin.* Note on consistent estimates of the linear structural relation between two variables: *E. L. Scott.* On multinomial distributions with limited freedom: a stochastic genesis of Pareto's and Pearson's curves: *M. Castellani.* On the completely unbiased character of tests of independence in multivariate normal systems: *R. D. Narain.* On the distribution of the two closest among a set of three observations: *G. R. Seth.*

1951]

September 1950—Fundamental limit theorems of probability theory: *M. Loève*. A random variable related to the spacing of sample values: *B. Sherman*. On a problem in the theory of k populations: *R. R. Bahadur*. Completeness in the sequential case: *E. L. Lehmann* and *C. Stein*. Some estimates and tests based on the r smallest values in a sample: *J. E. Walsh*. On the relative efficiencies of BAN estimates: *L. Katz*. Unbiased estimates with minimum variance: *C. Stein*. Distribution of maximum and minimum frequencies in a sample drawn from a multinomial distribution: *R. E. Greenwood* and *M. O. Glasgow*. Derivation of a broad class of consistent estimates: *R. C. Davis*. Distribution of the sum of roots of a determinantal equation under a certain condition: *D. N. Nanda*. A note on the power of a non-parametric test: *F. J. Massey, Jr.* On optimum selections from multinormal populations: *Z. W. Birnbaum* and *D. G. Chapman*. The distribution of distance in a hypersphere: *J. M. Hammersley*. A note on the asymptotic simultaneous distribution of the sample median and the mean deviation from the sample median: *R. K. Zeigler*. Note on the extension of Craig's Theorem to non-central variates: *O. Carpenter*. A second formula for the partial sum of hypergeometric series having unity as the fourth argument: *H. von Schelling*.

Biometrics—

September 1950—The construction and uses of fractional factorial designs in industrial research: *O. L. Davies* and *W. A. Hay*. Some remarks on animal population dynamics: *P. A. P. Moran*. Compound symmetry tests in the multivariate analysis of medical experiments: *D. F. Votaw, Jr.*, *A. W. Kimball* and *J. A. Rafferty*. A simple trend test with application to erythrocyte size data: *G. Elfving* and *J. H. Whitlock*. A note on the four by four Latin squares: *W. J. Youden*. An inverse sampling procedure for bacterial plate counts: *M. Sandelius*.

Econometrica—

October 1950—An electro-analog method: *N. F. Morehouse*, *R. H. Strotz* and *S. J. Horwitz*. A multiple-region theory of income and trade: *L. A. Metzler*. The multi-sector multiplier: *J. S. Chipman*. Identifiability of a linear relation between variables which are subject to error: *O. Reiersøl*.

Journal of Political Economy—

August 1950—Four positions on Japanese finance: *M. Bronfenbrenner*. The rate of interest and the marginal product of capital: *L. A. Metzler*. The development of utility theory, I: *G. J. Stigler*. A difficulty in the concept of social welfare: *K. J. Arrow*. Vertical integration and antitrust policy: *J. J. Spengler*. The United Nations and full employment: *K. K. Kurihara*.
October 1950—The development of utility theory, II: *G. J. Stigler*. The theory of employment and stabilization policy: *O. H. Brownlee*. Commodity and income taxation in the Soviet Union: *F. D. Holzman*. A method for drawing marginal curves: *L. W. McKenzie*.

Milbank Memorial Fund Quarterly—

July 1950—Changes in blood values during pregnancy and the relation of protein levels to toxemia symptoms: *D. Wiehl*. Population increase and manpower utilization in Imperial Japan: *I. B. Taeuber*. Social and psychological factors affecting fertility: *X. Fertility planning and fertility rates by religious interest and denomination: R. Freedman and P. K. Whelpton*.

Psychometrika—

September 1950—The problem of classification of personnel: *R. L. Thorndike*. Changes in common-factor loadings as tests are altered homogeneously in length: *J. P. Guilford* and *W. B. Michael*. A test of the equality of standard errors of measurement: *B. F. Green, Jr.* The reliability of speeded tests: *H. Gulliksen*. The discrimination of two racial samples: *P. Horst* and *S. Smith*. An experimental study of the effects on item-analysis data of changing item placement and test time limit: *W. G. Mollenkopf*. A proposed method for absolute scaling: *A. L. Comrey*.

Quarterly Journal of Economics—

August 1950—Joseph Alois Schumpeter, 1883-1950: *G. Haberler*. Full employment at whatever cost: *J. Viner*. Soviet national income and product in 1937. Part II: ruble prices and the valuation problem: *A. Bergson*. The international wheat agreement of 1949: *F. H. Golay*.

Review of Economics and Statistics—

August 1950—Taxation and redistribution in the United Kingdom: *F. Weaver*. Leontief's System in the light of recent results: *N. Georgescu-Roegen*. The effect of private pension plans on personal savings: *G. Garvy*. Discrimination and international trade policy: *R. Mikesell*. International measures for full employment: *G. N. Halm*. The employment multiplier in an expanding industrial market: Los Angeles County, 1940-47: *G. H. Hildebrand* and *A. Mace, Jr.*

November 1950—Flexible exchange rates and the theory of employment: *S. Laursen* and *L. A. Metzler*. Consumer knowledge: its measurement and extent: *A. R. Oxenfelt*. The productivity ratio: some analytical limitations on its use: *P. O. Steiner*. A new production index for Soviet industry: *D. R. Hodgman*. European rearmament and United States foreign aid: *E. Bloch*. Friction, Burns and Mitchell, and the transport building cycle: *W. Isard* and *L. Moses*.

AUSTRIA—

Statistische Vierteljahresschrift—

Vol. III, Part 2—Reproduktive Systeme und ihre Anwendungen in der technischen Statistik: *A. Adam*. Die Statistik in der Weltwetterforschung: *F. Steinhauser*. Abgangsordnung von Aktiengesellschaften: *G. Emsenhuber*. "Wer ist der Komponist?": *O. Winkler*.

BELGIUM—

Bulletin de l'Institut de Recherches Économiques et Sociales—

August 1950—Les chèques postaux: *A. Charlier*. La théorie de la demande et l'attente du consommateur: *J. Martin*.

September 1950—La conjoncture économique de la Belgique: *M. Woitrin*.

BRAZIL—

Revista Brasileira de Estatística—

October-December, 1949—Pesquisas em torno da curva das rendas: *R. D'Addario*. Envelhecer: um problema econômica-social: *J. G. Galé*. Séries estatísticas: *A. P. de Toledo*. Os diversos conceitos em matéria de índices: *R. Roy*.

FRANCE—

Journal de la Société Statistique de Paris—

July-September 1950—A propos de l'application de la loi de Gauss: *R. Risser*. Possibilités d'établissement d'un indice des prix des fruits et des légumes frais: *E. Malinvaud*. Quelques améliorations récentes apportées aux statistiques sanitaires en France et en particulier aux statistiques des causes de décès: *M. Aubenque*. Chronique de production industrielle: *R. Remery*. Chronique des statistiques financières: *J. de Portzamparc*. Tableaux du commerce international: *C. Rist*. Les machines mathématiques: *R. Henon*.

Population—

July-September 1950—Besoins et possibilités de l'immigration en France (deuxième partie): *A. Sauvy*. La structure de la population et la sécurité sociale: *J. Bourgeois-Pichat*. Perspectives relatives aux besoins de logements: *L. Henry*. L'Égypte, est-elle surpeuplée?: *E. Nassif*. Mobilité sociale et dimension de la famille: *M. Bresard*. Une enquête nationale sur le niveau intellectuel des enfants d'âge scolaire: *J. Stoetzel* and *A. Girard*.

Revue d'Économie Politique—

May-June 1950—Le consommateur et les nationalisations de l'industrie britannique: *A. M. de Neuman*. Les déséquilibres permanents de l'économie allemande: *A. Piettre*. L'explication des mouvements de prix en conjoncture: *A. Vincent*.

July-August 1950—Plein emploi et progrès économique: *P. Lassegue*. L'analyse structurale en économie: la théorie des jeux: *M. Lagache*. Le rôle des délais dans la théorie économique: *R. Roux*.

1951]

GERMANY—

Mitteilungsblatt für Mathematische Statistik—

Vol. 2, Part 2—Zur Begründung des Inklusions- und Repräsentations-schlusses der Mathematischen Statistik: *H. Richter*. Drei Nomogramme zur Bestimmung von Mittelwert-Toleranzen: *U. Graf* and *H. J. Henning*. Zur Frage der Errechnung der Einkommens-elastizität: *O. Anderson, jun.* Bemerkungen zur Anwendung statistischer Methoden in der Technik: *E. Rossow*. Glückstrad statt Urnenschema: *T. Dalenius*. Zur Abschätzung von Wahrscheinlichkeiten: *H. Münzner*. Deutsche Bezeichnungen für Fachausdrücke der Mathematische Statistik.

Weltwirtschaftliches Archiv—

Vol. 64, No. 2 (1950)—Equilibrium of international trade and international monetary compensations: *M. H. Ekker*.

Zeitschrift für Ökonometrie—

Vol. 1, Part 1 (June 1950)—Wesen und Bedeutung der Ökonometrie: *J. Tinbergen*. Betrachtungsweisen und Massstäbe in der Ökonomie: *F. Zeuthen*. Zur Grundlegung der Konjunkturtheorie: *W. Kellner*. Recent developments in welfare economics: *J. M. D. Lillte*. Die Bedeutung der Nachfrage- und Angebotselastizität für die Marktform: *L. J. Zimmerman*. Das Wachstum der Eisenbahnen: *F. Mothes*. On the distribution of a sum of squares over a linear subspace: *R. Frisch*. Der Begriff der Dynamik in der Wirtschaftstheorie: *W. Kellner*.

HOLLAND—

Statistica—

Vol. 4, No. 3-4—Het ontstaan een frequentieverdeling: *P. de Wolff*. Een demonstratie van de centrale limitstelling: *J. Sittig*. Frequentieverdeling en mengproblemen: *A. J. de Jong*. Twee frequentieverdelingen op het terrein van het voedingsonderzoek: *G. J. Fortuin*. Enige aspecten van de spreiding bij arbeidsprestaties: *J. R. de Jong*. Nabeschouwing: *P. de Wolff*.

ITALY—

Giornale degli Economisti e Annali di Economia—

July-September 1950—La distribuzione del reddito nazionale: *P. L. Fegiz*. Sulla "disegualianza dei redditi" nelle ipotesi paretiane: *F. Giaccardi*.

Statistica—

July-September 1950—Sulla metodologia del reddito di alcuni settori economici: *E. D'Elia*. La mortalità differenziale dei due sessi e le sue possibili cause: *N. Federici*. Sull'ammontare e la distribuzione del reddito nazionale in Italia: *A. Giannone*. Sulle correlazioni parziali: *V. Amata*. La legge sinusoidale delle serie derivate con somme mobili: *G. B. Ghidoli*.

JAPAN—

Institute of Statistical Mathematics, Annals—

Vol. II, No. 1 (August 1950)—On the abscissa of convergence of Laplace-Stieljes integral: *T. Ugaheri*. On the fundamental operations of collectives: *K. Matusita*. On a relation between exponential law and Poisson's law: *S. Nabeya*. A note on the classification of data: *H. Aoyama*. On certain groups of inequalities (confidence intervals for the mean): *H. Midzuno*. Approach for quantifying qualitative data from the mathematico-statistical point of view: *C. Hayashi*. Sampling design in literacy survey: *C. Hayashi, M. D. Ishida, S. Takakura, M. Taguma and M. Suzuki*. Yield trials with backcross derived lines of wheat: *G. A. Baker and F. N. Briggs*.

SWEDEN—

Skandinavisk Aktuarietidskrift—

Parts 1-2 1950—Some problems in the collective theory of risk: *G. Arfwedson*. Ein vernachlässigtes Interpolationsverfahren: *E. Kivikoski*. A study of the dependence of the premium on the rate of interest: *E. Zwinggi*. On inverse linear interpolation: *E. Michalup*. An attempt to classify life tables: *H. V. Muhsam*.

SWITZERLAND—

Mitteilungen der Vereinigung schweizerischer Versicherungsmathematiker—

October 1950—La distribution des revenus dans la technique mathématique de la sécurité sociale: *E. Kaiser.*

Schweizerische Zeitschrift für Volkswirtschaft und Statistik—

August 1950—La situation actuelle de l'entrepreneur privé: *J. Golay.* Mathematik und Statistik in Dienste der eidgenössischen Alters- und Hinterlassenenversicherung: *W. Wegmüller.* Wirtschaftspläne im Osten und Südosten Europas: *J. Rosen.* Empirische Konsum- und Sparfunktionen (Schluss): *C. la Roche.*

INTERNATIONAL—

International Labour Review—

September–October 1950—Prospects and problems of the textile industry in Western Germany: *R. Roux.*

November 1950—Post-war developments in the Japanese textile industry: *C. Hsieh.*

Revue de l'Institut International de Statistique—

Vol. 18, No. 1/2—On the sampling of physical materials: *W. E. Deming.* The use of sampling methods in national income statistics and social accounting: *J. R. N. Stone, J. E. G. Utting* and *J. Durbin.* Analyse de la mortalité infantile: *J. Bourgeois-Pichat.*

1951]

LIST OF ADDITIONS TO THE LIBRARY

Since the issue of Part IV, 1950, the Society has received the publications enumerated below.

I.—OFFICIAL PUBLICATIONS

(a) United Kingdom

Catering Wages Commission

Report on an inquiry into the operation of the Catering Wages Act, 1943, in the hotel industry. London, H.M.S.O., 1950. Cmd. 8004. [234 pp.] (various paging). 9½". 5s.

Colonial Office

Development and welfare in the West Indies, 1947–49: report by Major General Sir Hubert Rance . . . (Colonial 264.) London, H.M.S.O., 1950. 152 pp. 9½". 4s. 6d.

Interim report on the financial and economic structure of the Maltese Islands presented to the Prime Minister of Malta by Sir George E. Schuster . . . (Colonial 260.) London, H.M.S.O., 1950. xxviii pp. 12". 3s. 6d.

Social science research in Sarawak: a report on the possibilities of a social economic survey of Sarawak, presented to the Colonial Social Science Research Council by E. R. Leach . . . London, March, 1948–July, 1949. (Colonial Research Studies, 1.) London, H.M.S.O., 1950. 93 pp. 13". 8s. 6d.

Commonwealth Economic Committee

A survey of the trade in fertilizers. 34th report. London, H.M.S.O., 1950. vi, 126 pp. 9½". 3s. 6d.

Vegetable oils and oilseeds: a summary of figures of production, trade and consumption relating to groundnuts, cottonseed, linseed, soya beans, coconut and oil palm products, olive oil, and other oilseeds and oils. . . . London, H.M.S.O., 1950. xiv, 118 pp. 9½". 5s.

Education, Ministry of

The future development of higher technological education: report of the National Advisory Council on Education for Industry and Commerce. London, H.M.S.O., 1950. 28 pp. 9½". 1s.

Report of a special committee on education for commerce. London, H.M.S.O., 1949. vi, 79 pp. 9½". 1s. 6d.

Foreign Office

Anglo-French discussions regarding French proposals for the Western European coal, iron and steel industries, May-June, 1950. (Miscellaneous, 1950, 9) London, H.M.S.O., 1950. Cmd. 7970. 15 pp. 9½". 4d.

General Register Office

Cancer registration in England and Wales: an inquiry into treatment and its results; by Percy Stocks . . . (Studies on Medical and Population Subjects, 3.) London, H.M.S.O., 1950. ii, 80 pp. 9½". 2s.

Interdepartmental Committee on Social and Economic Research

Guides to official sources, No. 1. Labour statistics: material collected by the Ministry of Labour and National Service. Revised edition, August, 1950. London, H.M.S.O., 1950. v, 38 pp. 9½". 1s. 3d.

Report of the Interdepartmental Committee on Social and Economic Research. London, H.M.S.O. Cmd. 8091. 13 pp. 9½". 6d.

Lord High Chancellor. Leasehold Committee: final report. London, H.M.S.O., 1950. Cmd. 7982. 162 pp. 9½". 4s.

Lord President of the Council. Second Report of the Committee on Industrial Productivity. London, H.M.S.O. 1950. Cmd. 7991. 10 pp. 9½". 4d.

VOL. CXIV. PART I.

Medical Research Council

- Special Report Series, 183. Reports on biological standards: III. Methods of biological assay depending on a quantal response, by J. H. Gaddum. 1933. 48 pp. 9½". 1s.
- 202. Reports on biological standards: IV. The standardization and estimation of vitamin A; edited by E. Margaret Hulme and Harriette Chick. 1935. 61 pp. 9½". 1s.
- 267. Researches on the radio-therapy of oral cancer, by Constance A. P. Woodland, J. W. Boag (with P. Howard-Flanders, A. Glucksmann, L. H. Gray and F. G. Spear). 1950. 148 pp. 9½". 12s. 6d. London, H.M.S.O.

Scotland, Department of Agriculture for. Scottish farming: thirteenth economic report 1945/46—1947/48. Edinburgh, H.M.S.O., 1950. 24 pp. 13". 2s. 6d.

Town and Country Planning, Ministry of. Department of Health for Scotland. Report of the committee on qualifications of planners. . . London, H.M.S.O., 1950. Cmd. 8059. vi, 85 pp. 9½". 2s. 6d.

Trade, Board of. Commercial Relations and Exports Department. Overseas economic surveys: Australia. . . November, 1949. 1950. iv, 154 pp. Map. 4s. Colombia. . . December, 1949. 1950. ii, 42 pp. 1s. 3d. Cuba . . . September, 1949. 1950. vi, 89 pp. 2s. 6d. Ecuador . . . January, 1950. iv, 47 pp. Map. 1s. 6d. Sweden . . . April, 1950. vii, 143 pp. 3s. 6d. London, H.M.S.O., 1950. 9½".

Transport, Ministry of. Return of shipping casualties and deaths, 1948: vessels registered in the United Kingdom, with summary tables for the years 1939–1947. London, H.M.S.O., 1950. 23 pp. 13½". 1s. 6d.

Treasury. Final report of the Committee on the Form of Government Accounts. London, H.M.S.O., 1950. 88 pp. 9½". 2s.

Treasury. Organization and Methods Division. Public administration: a bibliography for organization and methods. January, 1950. London, H.M.S.O., 1950. 18 pp. 12½". 1s.

(b) Other National and International Publications

Falkland Islands

Report of census taken on the night of the 31st March, 1946. Stanley, Government Printer, [1946]. 20 pp. 13".

France

Institut National de la Statistique et des Études Économiques. Direction de la Statistique Générale. Résultats statistiques du recensement général de la population effectué le 10 mars 1946. Volume V, Infirmités. Paris, 1950. lxxi, 38 pp. 10½".

Ministère de la France d'Outre-Mer. Documents et statistiques IV. La monnaie et le crédit dans les territoires d'outre mer. Paris, Service des Statistiques, 1950. 323 pp. 10½".

Germany

Statistisches Bundesamt. Statistik der Bundesrepublik Deutschland. Bd. 2. Ausgaben und Einnahmen der staatlichen Verwaltung (Vereinigtes Wirtschaftsgebiet, britische Zone, Länder) für das Rechnungsjahr 1947. Teil II. Gliederung nach Ländern. 87 pp.

— Bd. 3. Die kommunalen Finanzen im Rechnungsjahr 1948. 52 pp.

— Bd. 4. Ausgaben und Einnahmen der staatlichen Verwaltung (Vereinigtes Wirtschaftsgebiet und Länder) DM-Abschnitt des Rechnungsjahres 1948. 159 pp.

— Bd. 5. Das Arbeitsgebiet des Statistischen Bundesamtes mit Verzeichnissen der Statistiken, der Veröffentlichungen und des Inhalts von "Wirtschaft und Statistik" Stand Mitte 1950. 42 pp.

— Bd. 6. Die Seeschifffahrt im Jahre 1948. 90 pp.

— Bd. 7. Die Binnenschifffahrt im Jahre 1948. 103 pp.

— Bd. 9. Die Binnenschifffahrt im Jahre 1949. 106 pp. Stuttgart—Köln, W. Kohlhammer, 1950. 11½".

1951]

India

Registrar-General. Census of India. Paper No. 5, 1950. Age tables. Bihar, 1941, on Y sample. Delhi, 1950. 25 pp. 10½".

International Monetary Fund

Balance of Payments Division. Balance of payments yearbook, 1948, and preliminary 1949. Washington, I.M.F., 1950. 428 pp. 11".

New Zealand

Census and Statistics Department. Population census, 1945. Appendix B: War service. Wellington, 1950. 20 pp. 12¼". 2s. 6d.

Norway

Statistisk Sentralbyrå. Lønnstillingen, jern-og metallindustri, tekstil industri, kjemisk og elektrokjemisk industri 1948. (Norges Offisielle Statistikk, xi, 10.) Oslo, 1950. 169 pp. 9½".

Swaziland

Swaziland census, 1946. Mbabane, 1950. xvi, 59 pp. 9¾".

Sweden

Statistiska Centralbyrån. Folkräkningen den 31 December 1945 av Statistiska Centralbyrån, VII: partiella undersökningar (Tolvtedelssamplingen) behandlar delar av familjestatistiken. Stockholm, 1950. xvi, 123, 86 pp. 9½".

United Nations

Department of Economic Affairs. Implementation of full employment policies. Report No. 1. Measures taken in the second half of 1949 by various countries for the purpose of achieving full employment. (1950, II.A.1.) Lake Success, 1950. (London, H.M.S.O.), 52 pp. 9". 3s.

Department of Social Affairs

Population studies No. 1. The population of Western Samoa. (1948. xiii. 1). vi, 61 pp. 11". 2s. 6d.

— No. 2. The population of Tanganyika. (1949. xiii. 2). viii, 151 pp. 10½". 7s. 6d

— No. 5. Problems of migration statistics. (1950. xiii. 1). vii, 65 pp. 11". 4s. 6d

— No. 6. Fertility data in population censuses. (1950. xiii. 2). iii, 31 pp. 11".

— No. 8. Data on urban and rural population in recent censuses. (1950. xiii. 4). vi, 27 pp. 11". Lake Success (London, H.M.S.O.)

Statistical Office

Statistical papers, Series C, No. 1 (revised). The preparation of sampling survey reports. 13 pp. 1950. 10½".

— Series C, No. 2. Sample surveys of current interest. 1949. 51 pp. 10½".

— Series C, No. 3. Sample surveys of current interest (second report). 1949. 32 pp. 10½".

— Series E, No. 1. National and *per capita* incomes of seventy countries in 1949, expressed in United States dollars. 1950. 29 pp. 10½".

— Series M, No. 2. Report on the first Latin American training centre on statistics and censuses held at Mexico City . . . 1948. 1949. 33 pp. 10½".

— Series M, No. 3. Indexes of quantum in international trade: methods of adjustment for incomplete coverage. 1949. 14 pp. 10½".

— Series M, No. 5. Report on the European Centre of applied Agricultural and Demographic Statistics. Paris, 1949. 1950. 28 pp. 10½".

— Series M, No. 6. Report on the international training centre on statistics and censuses for the Near East countries. Cairo, 1949. 1950. 15 pp. 10½".

— Series M, No. 8. International standard definitions for transport statistics. 1950. 29 pp. 10½". Lake Success, Statistical Office.

Studies in methods, No. 1. Index numbers of industrial production. Lake Success, Statistical Office, 1950. (London, H.M.S.O.) 60 pp. 10½". 1s. 9d.

VOL. CXIV. PART I.

9§

United States of America

National Bureau of Standards

- Tables of scattering functions for spherical particles. (Applied mathematics series, 4.) Washington, Government Printing Office, 1949. xii, 119 pp. 10 $\frac{1}{4}$ ".
- Tables of the binomial probability distribution. (Applied mathematics series, 6.) Washington, Government Printing Office, 1949. x, 387 pp. 10 $\frac{1}{4}$ ". \$2.50 (buckram).

II.—AUTHORS AND MISCELLANEOUS

- ABRAMOVITZ (MOSES). Inventories and business cycles with special reference to manufacturers' inventories. (Studies in business cycles, 4.) New York, Nat. Bur. of Economic Research, 1950. xxxv, [iv] 632 pp. 9". \$6.
- BOULDING (KENNETH E.). A reconstruction of economics ... New York, John Wiley, 1950. (London, Chapman & Hall). xiii, 311 pp. 9". 36s.
- BRITISH MARKET RESEARCH BUREAU. Self service in Great Britain: a study of the latest method of grocery retailing. London, 1950. vi, 72 pp. 9 $\frac{1}{2}$ ".
- CLARKE (CHARLES E.). Social insurance in Britain: a textbook for actuarial students ... Cambridge University Press (published for the Institute of Actuaries and the Faculty of Actuaries), 1950. x, 136 pp. 9". 13s. 6d.
- CONNELL (K. H.). The population of Ireland, 1750-1845 ... Oxford, Clarendon Press, 1950. xi, 293 pp. 8 $\frac{1}{2}$ ". 18s.
- COX (PETER R.). Demography ... Cambridge University Press (Published for the Institute of Actuaries and the Faculty of Actuaries). 1950. xii, 326 pp. 9". 20s.
- CREDIT COMMUNAL DE BELGIQUE. Tables d'intérêts et d'annuités: éditées par le Crédit Communal de Belgique ... Brussels, 1950. 163 pp. 13 $\frac{1}{4}$ " x 10".
- DAVID (LILY MARY). Economic status of library personnel, 1949: prepared by Lily Mary David, United States ... Bureau of Labor Statistics, Division of Wage Statistics, Chicago. American Library Association, 1950. [6] 117 pp. 11".
- DE BEER (EDWIN J.), *editor*. The place of statistical methods in biological and chemical experimentation; by Edwin J. de Beer, H. C. Batson, C. I. Bliss, K. A. Brownlee, Gertrude Cox, Robert A. Harte, Lila F. Knudsen, H. M. C. Luykx, Donald Mainland, Lloyd C. Miller, D. D. Reid, George W. Snedecor, Bert J. Vos, Frank Wilcoxon, C. V. Winder and W. J. Youden ... *Ann. N.Y. Acad. Sci.* (1950), 52, 789-842. 9 $\frac{1}{4}$ ". \$2.75.
- DELENS (A. H. R.). Principles of market research ... London, Crosby Lockwood, 1950. 254 pp. 8 $\frac{1}{2}$ ". 15s.
- DEMING (WILLIAM EDWARDS). Some theory of sampling ... New York, John Wiley, 1950. (London, Chapman & Hall.) xvii, 602 pp. 9". 72s.
- DEVONS (ELY). Planning in practice: essays in aircraft planning in war-time ... Cambridge University Press, 1950. viii, 231 pp. 8 $\frac{1}{2}$ ". 15s.
- DUDLEY (F. J.) and READ (D. R.). The design of experiments in egg production of poultry. *Harper Adams Utility Poultry J.* (1949), 34 N.S. 2. 20 pp. 9 $\frac{3}{4}$ ".
- DUNLOP (JOHN T.). Wage determination under trade unions ... Oxford, Basil Blackwell, 1950. x, 230 pp. 8 $\frac{1}{2}$ ". 20s.
- FELLER (WILLIAM). An introduction to probability theory and its applications ... Vol. I. New York, John Wiley, 1950. (London, Chapman & Hall.) xii, 419 pp. 9". 48s.
- FISHER (RONALD AYLMER). Contributions to mathematical statistics: index prepared by John Tukey. New York, John Wiley, 1950. (London, Chapman & Hall.) [694 pp.] front. 11". 60s.
- FRICKEY (EDWIN). Economic fluctuations in the United States: a systematic analysis of long-run trends and business cycles, 1866-1914 ... (Harvard economic studies, lxxiii.) Cambridge, Mass., Harvard University Press, 1942. xxi, 375 pp. 9". 32s. 6d.
- GRUNDY (P. M.). The estimation of error in rectangular lattices. *Biometrics* (1950), 6, 25-33. 9 $\frac{1}{2}$ ".
- HAMMOND (J. L.) and HAMMOND (BARBARA). The rise of modern industry ... 7th ed. London, Methuen, 1947. xii, 303 pp. 8 $\frac{1}{2}$ ". 11s. 6d.
- HARTREE (DOUGLAS). Calculating instruments and machines ... Cambridge University Press, 1950. ix, 138 pp. 9 $\frac{1}{2}$ ". 21s.
- HEALY (M. J. R.). Routine computation of biological assays involving a quantitative response. *Biometrics* (1949), 5, 330-334. 9 $\frac{1}{2}$ ".
- HEIDINGFIELD (MYRON S.) and BLANKENSHIP (ALBERT B.). Market and marketing analysis ... New York, Henry Holt, 1948. x, 335 pp. 8 $\frac{1}{4}$ ". 25s.

1951]

- INSTITUTE OF ACTUARIES. Proceedings of the Centenary Assembly of the Institute of Actuaries ... Cambridge, printed for the Institute of Actuaries at the University Press, 1950. 3 vols. 8 $\frac{3}{4}$ ". (Presented by the Institute.)
- INSTITUT INTERNATIONAL DE STATISTIQUE. Bulletin de l'Institut International de Statistique. Travaux présentés à la 26e Session de l'Institut International de Statistique, Berne, 1949. (Tome xxxii, 2e livraison.) The Hague, 1950. vi, 488 pp. 10".
- Applications de la méthode statistique dans l'industrie ... Travaux présentés à la 26e Session ... Berne, 1949. *Bull. Inst. Int. Statist.*, 32 (1950), 2 liv., 19-113. 10".
- JAMES (GLENN) and JAMES (ROBERT C.). *Editors*. Mathematics dictionary; by A. A. Alchian ... E. E. F. Beckenbach ... C. Bell ... H. V. Craig ... G. James ... R. C. James ... A. D. Michal ... I. S. Sokolnikoff ... New York, D. van Nostrand, 1949. v, 432 pp. 9". 56s.
- JOHNSON (N. L.) and TETLEY (H.). Statistics: an intermediate textbook ... Vol. II. Cambridge University Press (published for the Institute of Actuaries and the Faculty of Actuaries), 1950. xi, 318 pp. 8 $\frac{1}{2}$ ". 20s.
- KLIEN (LAWRENCE R.). Economic fluctuations in the United States 1921-41 ... (Cowles Commission Monographs, 11.) New York, John Wiley, 1950. (London, Chapman & Hall.) xi, 174 pp. 9". 32s.
- KOOPMANS (TJALLING), *editor*. Statistical inference in dynamic economic models; by Cowles Commission Research Staff, members and guests; edited by Tjalling C. Koopmans (Cowles Commission Monographs, 10.) New York, John Wiley, 1950. (London, Chapman & Hall.) xiv, 438 pp. 9 $\frac{3}{4}$ ". 48s.
- KUIPERS (JOHN DENNIS). Resale price maintenance in Great Britain, with special reference to the grocery trade ... Wageningen, N. V. Drukkerij "Vada," 1950. xi, 251 pp. 9 $\frac{1}{2}$ ". (Presented by the author.)
- KUZNETS (SIMON). Shares of upper income groups in income and savings ... (Occasional paper, 35.) New York, Nat. Bur. of Economic Research, 1950. 68 pp. 9". \$1.
- LÉVY (PAUL). Processus stochastiques et mouvement brownien: par Paul Lévy ... suivi d'une note de M. Loève. (Monographies des probabilités, vi.) Paris, Gauthier-Villars, 1948. 365 pp. 10". 70s.
- LUNDBERG (GEORGE A.). Social research: a study in methods of gathering data ... 2nd ed. New York and London, Longmans, 1949. xx, 426 pp. 8". 28s. 6d.
- Marketing survey of the United Kingdom, with new county-by-county survey. *Editor*, Cecil Chisholm; Advisory Committee on Statistics, W. Coghlan ... G. Cranch ... E. A. Lever ... J. I. Mason ... L. T. Wilkins ... London, Business Publications, Ltd., 1951 [1950]. 598 pp. 9 $\frac{3}{4}$ ". 105s.
- MILLER (DONALD C.). Taxes, the public debt, and transfers of income ... (Illinois studies in the social sciences, xxxii, 1.) Urbana, University of Illinois Press, 1950. xi, 153 pp. 10". \$2.
- MOOD (ALEXANDER MCFARLANE). Introduction to the theory of statistics ... New York and London, McGraw-Hill, 1950. xiii, 433 pp. 9". 42s. 6d.
- OFFICE MANAGEMENT ASSOCIATION. Clerical salaries analysis 1950 (as at 1st March, 1950). London, O.M.A., 1950. 85 pp., folded appendix. 9 $\frac{3}{4}$ ". 21s.
- OXFORD INSTITUTE FOR RESEARCH IN AGRICULTURAL ECONOMICS. Occasional papers: I. Contrasts in agricultural price policies: a study in some economic policies of the United States of America, New Zealand, and the United Kingdom; by A. I. Marsh. 29 pp. 8 $\frac{1}{2}$ ".
- II. An outline of economic principles in farm organization and management; by A. H. Maunders. 21 pp. 8 $\frac{1}{2}$ ". Oxford, The Institute, 1950.
- PAISH (F. W.). The post-war financial problem, and other essays ... London, Macmillan, 1950. ix, 263 pp. 8 $\frac{1}{2}$ ". 15s.
- PATERSON (RALSTON), TOD (MARGARET), and RUSSELL (MARION), *editors*. The results of radium and X-ray therapy in malignant disease: being the third statistical report from the Radium Institute, the Christie Hospital, and Holt Radium Institute, Manchester; years 1940 to 1944 inclusive assessed at 5 years and 1934 to 1938 assessed at 10 years ... Edinburgh, E. & S. Livingstone, 1950. 167 pp. 9 $\frac{1}{2}$ ". 10s. 6d.
- PUFFER (RUTH RICE). Practical statistics in health and medical work ... New York and London, McGraw-Hill, 1950. xiii, 238 pp. 8". 36s. 6d.
- QUENOUILLE (M. H.). Introductory statistics ... London, Butterworth-Springer, 1950. xi, 248 pp. 9 $\frac{3}{4}$ ". 30s.
- RAO (C. RADHAKRISHNA). Finite geometries and difference sets and combinatorial arrangements derivable from them. *Proc. Nat. Inst. Sci. India* (1945). 11, 136-145. 9 $\frac{3}{4}$ ".
- Hypercubes of strength "d" leading to confounded designs in factorial experiments. *Bull. Calcutta Math. Soc.* (1946), 38, 67-78. 9 $\frac{1}{2}$ ".

- RAO (C. RADHAKRISHNA). Information and the accuracy attainable in the estimation of statistical parameters. *Bull. Calcutta Math. Soc.* (1945), 37, 81-91. 9½".
- Large sample tests of statistical hypotheses concerning several parameters with application to problems of estimation. *Proc. Camb. Phil. Soc.* (1947), 44, 50-57. 10".
- Methods of scoring linkage data giving the simultaneous segregations of three factors. *Heredity* (1950), 4, 37-59. 9¾".
- Minimum variance and the estimation of several parameters. *Proc. Camb. Phil. Soc.* (1946), 43, 280-283. 10".
- A note on unbiased and minimum variance estimates. *Calcutta Statist. Bull.* (1950), 3, 36. 10".
- On a class of arrangements. *Edin. Math. Proc.* (1949), Series 2, 8, 119-125. 10".
- Sufficient statistics and minimum variance estimates. *Proc. Camb. Phil. Soc.* (1948), 45, 213-218. 10". (Presented by the author.)
- READ (D. R.). A study of the accuracy of simple sampling methods for the estimation of egg production and mean egg weight. *J. Agric. Sci.* (1949), 39, 259-264. 10".
- ROBSON (T. B.). Holding companies and their subsidiaries: consolidated and other group accounts, principles and procedure ... London, Gee & Co., 1950. 152 pp. 8½". 18s.
- STAPLES (RONALD), editor. "Taxation" manual; compiled by barristers and experts under the direction of Ronald Staples ... 6th ed. London: Taxation Publishing Co., 1950. xx, 411 pp. 8¼". 15s.
- and HUGHES (PERCY F.). Staples on back duty: being a consideration of the law and practice relating to the settlement of liability to income-tax, sur-tax, excess profits duty, profits tax, excess profits tax, interest and penalties where income has escaped assessment at the proper time. ... London, Gee & Co., 1950. 150 pp. 8½". 21s.
- TINBERGEN (JAN), and POLAK (J. J.). The dynamics of business cycles: a study in economic fluctuations. ... London, Routledge, 1950. x, 366 pp. 8½". 25s.
- VERNON (PHILLIP E.). The structure of human abilities. ... London, Methuen, 1950. [10] 160 pp. 8½". 12s. 6d.
- WALD (ABRAHAM). Statistical decision functions. New York, John Wiley, 1950. (London, Chapman & Hall.) ix, 179 pp. bibliog. 8". 40s.
- WALKER (HELEN M.). Mathematics essential for elementary statistics: a self-teaching manual. ... New York and London, Henry Holt, 1949. xiii, 246 pp. 7½". 18s.
- WHYTE (LEWIS G.). Principles of finance and investment. ... Vol. I, Economic background, Company finance, National economy. xi, 192 pp. 12s. 6d. Vol. II, Money market, Rate of interest, Analysis of investments, Life office investments. vii, 176 pp. 12s. 6d. Cambridge University Press, 1950. (Published for the Institute of Actuaries and the Faculty of Actuaries.) 2 vols. 8½".
- YATES (F.). Agriculture, sampling and operational research. Rothamsted. 8 pp. 10".
- The design of rotation experiments. *Commonwealth Bur. Soil Sci. Technical Communication* (1949), 46. 16 pp. 9¾".
- and BOYD (D. A.). The relative yields of different crops in terms of food and their response to fertilizers. *Agric. Progress* (1949), 24, 1-11. 10".
- ZIMMERMANN (LUDWIG). Vollständige Tafeln der Quadrate aller Zahlen bis 100,009. Berlin, 1938. (Lithoprinted by Edwards Brothers, Ann Arbor, Mich., 1946.) xix, 187 pp. 10".

1951]

REVENUE OF THE UNITED KINGDOM
Net Produce in Quarters of 1950, and the Financial Years ended
March 31, 1949-50, 1948-49, 1947-48, 1946-47
 (000's omitted)

QUARTERS ended	March 31, 1950	June 30, 1950	Sept. 30, 1950	Dec. 31, 1950	Total for Calendar Year 1950
	£	£	£	£	£
Inland Revenue—	876,248	184,972	194,298	168,480	1,423,998
Income tax	66,400	23,100	12,100	15,400	117,000
Surtax	46,200	50,600	40,850	45,100	182,750
Death duties	12,570	12,215	12,485	14,760	52,030
Stamps	60,600	44,420	79,350	77,250	261,620
Profits tax	4,400	3,700	4,250	1,200	13,550
Excess profits tax	558	50	10	30	648
Other Inland Revenue duties	2,500	1,570	1,230	1,100	6,400
Special contribution					
Total Inland Revenue	1,069,476	320,627	344,573	323,320	2,057,996
Customs	201,404	215,431	222,922	230,436	870,193
Excise	179,700	168,200	180,800	183,400	712,100
Total Customs and Excise	381,104	383,631	403,722	413,836	1,582,293
Motor vehicle duties	42,869	5,234	4,903	4,266	57,272
Sale of surplus war stores	11,942	10,412	13,260	11,715	47,329
Surplus receipts from certain trading services	4,550	25,974	5,000	10,931	46,455
Post Office (net receipts)	714			700	1,414
Broadcast receiving licences	4,410	2,450	2,200	4,000	13,060
Receipts from sundry loans	7,893	1,389	16,685	1,565	27,642
Miscellaneous receipts (including Crown lands)	13,366	19,037	22,963	21,912	77,168
Total Ordinary Revenue	1,536,324	768,754	813,306	792,245	3,910,629
Self-balancing Revenue—					
Post Office	41,886	40,300	41,900	44,800	168,886
Income tax deducted from excess profits tax, post-war refunds	2,509	2,658	2,121	1,863	9,151

YEARS ended March 31	1949-50	1948-49	1949-50 (compared with 1948-49)		Corresponding Years	
			Increase	Decrease	1947-48	1946-47
Inland Revenue—						
Income tax	1,438,386	1,367,570	70,816	..	1,189,728	1,156,233
Surtax	114,700	97,900	16,800	..	91,220	75,742
Death duties	189,600	177,141	12,459	..	172,029	148,044
Stamps	51,470	56,433	..	4,963	56,280	38,338
Profits tax	260,760	199,090	61,670	..	36,120	..
Excess profits tax	36,200	79,805	..	43,605	252,568	325,391
Other Inland Revenue duties	638	700	..	62	715	724
Special contribution	19,600	79,450	..	59,850	..	..
National defence contribution .. .. .	..	..	..	..	..	32,107
Total Inland Revenue	2,111,354	2,058,089	161,745	110,840	1,798,660	1,776,579
Customs	813,334	823,258	..	9,924	791,101	620,741
Excise	706,400	733,500	..	27,100	629,700	563,500
Total Customs and Excise	1,519,734	1,556,758	..	37,024	1,420,801	1,184,241
Motor vehicle duties	55,772	52,716	3,056	..	49,108	49,456
Sale of surplus war stores	79,138	99,597	..	20,459	197,231	155,996
Surplus receipts from sundry trading services	47,541	28,564	18,977	..	101,261	59,000
Post Office (net receipts) .. .. .	..	..	..	..	..	..
Broadcast receiving licences	12,600	11,700	900	..	11,200	9,940
Receipts from sundry loans	20,244	17,683	3,561	..	23,044	26,779
Miscellaneous receipts (including Crown lands)	77,648	181,483	..	103,835	243,553	79,232
Total Ordinary Revenue	3,924,031	4,006,590	187,239	269,798	3,844,859	3,341,223
Self-balancing Revenue—			NET DECR. £82,559			
Post Office	162,100	152,700	9,400	..	143,300	131,000
Income tax deducted from excess profits tax, post-war refunds	11,893	8,751	3,142	..	83,183	150,522

BANK OF ENGLAND

Pursuant to the Act 7th and 8th Victoria, cap. 32 (1844)

(000's omitted)

1	2	3	4	5	6	7	8
ISSUE DEPARTMENT						COLLATERAL COLUMNS	
Liabilities	DATES	Assets				Notes in Hands of Public	Minimum Discount Rate
Notes Issued	(Wednesdays)	Govt. Debt (£11,015) and Govt. Securities	Other Securities	Gold Coin and Bullion*	Silver Coin†		
£		£	£	£	£	£	
1,350,357	Jan. 4	1,349,281	709	357	10	1,299,663	2%
1,300,357	" 11	1,299,252	738	357	10	1,280,489	
1,300,357	" 18	1,299,359	630	357	11	1,260,354	
1,300,357	" 25	1,299,278	708	357	14	1,247,697	
1,300,357	Feb. 1	1,299,284	704	357	12	1,245,473	
1,300,357	" 8	1,299,333	655	357	12	1,246,356	
1,300,357	" 15	1,299,285	704	357	11	1,248,522	
1,300,357	" 22	1,299,289	704	357	7	1,247,157	
1,300,357	Mar. 1	1,299,285	704	357	11	1,250,794	
1,300,357	" 8	1,299,420	569	357	11	1,257,623	
1,300,357	" 15	1,299,359	628	357	13	1,261,018	
1,300,357	" 22	1,299,281	708	357	11	1,260,409	
1,300,357	" 29	1,299,333	656	357	11	1,267,251	
1,300,357	Apr. 5	1,299,318	673	357	9	1,282,057	
1,300,357	" 12	1,299,285	703	357	12	1,288,094	
1,300,357	" 19	1,299,262	724	357	14	1,282,655	
1,300,357	" 26	1,299,282	704	357	13	1,277,731	
1,300,357	May 3	1,299,353	637	357	10	1,280,317	
1,300,357	" 10	1,299,279	711	357	10	1,283,775	
1,300,357	" 17	1,299,285	705	357	10	1,280,858	
1,300,357	" 24	1,299,322	666	357	12	1,281,680	
1,300,357	" 31	1,299,280	706	357	14	1,286,637	
1,300,357	June 7	1,299,241	745	357	14	1,289,644	
1,300,357	" 14	1,299,252	736	357	12	1,291,426	
1,300,357	" 21	1,299,298	690	357	12	1,289,247	
1,350,357	" 28	1,349,367	618	357	15	1,293,859	
1,350,357	July 5	1,349,213	776	357	11	1,302,603	
1,350,357	" 12	1,349,286	704	357	10	1,308,435	
1,350,357	" 19	1,349,283	704	357	13	1,311,444	
1,350,357	" 26	1,349,314	675	357	11	1,319,730	
1,350,357	Aug. 2	1,349,287	703	357	10	1,328,875	
1,350,357	" 9	1,349,033	703	357	264	1,329,350	
1,350,357	" 16	1,348,692	797	357	511	1,319,569	
1,350,357	" 23	1,348,503	680	357	1,014	1,307,483	
1,350,357	" 30	1,347,818	671	357	1,510	1,302,031	
1,350,357	Sept. 6	1,347,109	727	357	2,164	1,298,968	
1,350,357	" 13	1,346,357	703	357	2,663	1,294,187	
1,350,357	" 20	1,346,245	642	357	3,113	1,286,099	
1,350,357	" 27	1,345,701	639	357	3,660	1,283,254	
1,350,357	Oct. 4	1,345,283	704	357	4,013	1,282,726	
1,350,357	" 11	1,345,223	765	357	4,012	1,280,976	
1,350,357	" 18	1,345,285	704	357	4,011	1,278,593	
1,350,357	" 25	1,345,181	805	357	4,014	1,272,628	
1,350,357	Nov. 1	1,345,232	756	357	4,012	1,275,479	
1,350,357	" 8	1,345,235	741	357	4,014	1,278,350	
1,350,357	" 15	1,345,287	699	357	4,014	1,279,959	
1,350,357	" 22	1,345,310	675	357	4,015	1,279,555	
1,350,357	" 29	1,345,277	708	357	4,015	1,286,027	
1,350,357	Dec. 6	1,345,232	756	357	4,012	1,307,992	
1,375,357	" 13	1,345,231	756	357	4,013	1,339,318	
1,375,357	" 20	1,345,185	790	357	4,015	1,351,303	
1,375,357	" 27	1,345,333	655	357	4,012	1,357,678	

* At 172s. 3d. per fine oz.

† Coin other than Gold Coin.

1951]

WEEKLY RETURN

for Wednesday in each Week, during the year 1950

(000's omitted)

9	10	11	12	13	14	15	16	17	18
BANKING DEPARTMENT									
Liabilities				DATES (Wednes- days)	Assets				Totals of Liabilities and Assets
Capital (£14,553) and Rest	Public Deposits†	Bankers' Deposits	Other Deposits		Govt. Securi- ties	Dis- counts and Ad- vances	Other Securi- ties	Reserve (Notes and Coin)	
£	£	£	£		£	£	£	£	£
18,162	117,183	292,912	115,062	Jan. 4	440,944	23,687	23,352	55,936	543,919
18,204	124,887	298,709	112,166	" 11	482,544	23,167	23,079	25,176	553,966
18,244	132,853	291,722	111,304	" 18	466,629	19,232	22,842	45,420	554,123
18,282	129,894	291,668	110,220	" 25	453,659	14,715	23,755	57,935	550,064
17,321	133,439	288,011	113,427	Feb. 1	446,524	18,213	28,467	59,994	553,198
18,358	140,144	288,914	114,321	" 8	448,094	21,917	32,472	59,254	561,737
18,393	150,087	287,177	115,733	" 15	468,199	19,667	26,412	57,112	571,390
18,425	149,936	285,189	113,516	" 22	463,914	21,958	22,828	58,365	567,065
18,763	149,723	284,331	116,379	Mar. 1	457,839	22,725	33,674	54,638	568,896
18,484	166,406	281,151	74,366	" 8	447,894	20,922	23,572	47,989	540,377
18,503	163,847	293,558	79,370	" 15	463,529	23,088	23,945	44,716	555,278
18,522	171,872	290,451	79,744	" 22	472,984	18,053	24,245	45,307	560,589
18,448	172,100	283,499	83,880	" 29	474,549	12,274	32,657	38,547	558,027
17,713	169,307	285,381	83,424	Apr. 5	496,316	12,227	23,486	23,796	555,825
17,747	187,074	283,087	84,760	" 12	519,507	13,588	21,884	17,689	572,668
17,772	183,901	293,318	86,101	" 19	510,866	23,686	23,301	23,239	581,092
17,809	183,723	288,786	89,510	" 26	501,001	22,010	28,405	28,412	579,828
17,822	197,166	277,972	88,753	May 3	500,221	21,782	33,770	25,940	581,713
17,882	202,366	275,220	92,820	" 10	520,422	15,532	29,642	22,692	588,288
17,920	201,197	286,740	93,813	" 17	532,502	13,442	28,025	25,701	599,670
17,938	197,299	295,682	94,058	" 24	537,291	18,181	24,630	24,875	604,977
17,993	200,378	281,326	94,201	" 31	524,671	19,055	30,230	19,952	593,898
18,025	208,295	285,866	95,918	June 7	551,271	15,870	23,968	16,995	608,104
18,250	209,579	285,134	93,162	" 14	554,806	12,535	23,264	15,330	605,935
18,102	208,959	287,840	91,634	" 21	550,941	14,269	23,758	17,587	606,535
18,153	220,872	292,114	96,499	" 28	513,826	15,414	35,425	62,972	627,638
18,194	231,315	292,366	97,114	July 5	537,611	23,144	23,972	54,262	638,989
18,204	247,295	282,915	96,249	" 12	553,371	18,236	24,541	48,535	644,683
18,264	240,719	300,128	95,195	" 19	568,651	15,069	24,969	45,617	654,306
18,296	251,564	286,846	97,867	" 26	572,717	17,964	26,455	37,437	654,573
18,330	257,733	293,111	98,649	Aug. 2	596,067	14,846	28,635	28,275	667,823
18,378	262,288	285,704	97,907	" 9	600,332	11,051	25,384	27,510	664,277
18,405	259,540	292,509	97,820	" 16	591,486	14,251	25,423	37,114	668,274
18,428	264,609	283,339	96,229	" 23	576,942	14,661	22,201	48,801	662,805
18,451	250,271	278,767	95,709	" 30	539,166	23,354	35,858	53,820	652,198
18,473	259,885	279,056	95,151	Sept. 6	549,576	22,164	24,643	56,182	652,565
18,488	260,622	283,235	96,141	" 13	548,562	24,519	24,946	60,459	658,486
18,509	271,644	290,236	91,537	" 20	560,216	18,798	25,038	67,874	671,926
18,530	269,613	291,764	94,305	" 27	547,426	21,033	35,558	70,195	674,212
18,549	267,647	296,011	93,511	Oct. 4	562,256	18,798	24,319	70,345	675,718
17,711	282,883	300,921	91,905	" 11	567,672	28,683	24,985	72,080	693,420
17,745	279,524	309,315	88,864	" 18	544,201	51,242	25,563	74,442	695,448
17,763	279,370	315,979	89,336	" 25	555,271	40,327	26,538	80,312	702,448
17,825	279,465	304,930	90,223	Nov. 1	555,266	32,224	27,749	75,204	692,443
17,861	281,692	308,350	86,725	" 8	558,141	30,576	31,556	74,355	694,628
17,902	283,804	305,782	86,456	" 15	559,941	33,970	27,395	72,638	693,944
17,938	285,125	307,481	82,814	" 22	556,981	37,796	25,757	72,824	693,358
17,973	284,774	304,955	82,170	" 29	550,546	37,816	35,361	66,149	689,872
17,986	280,624	302,741	85,447	Dec. 6	581,881	35,942	25,041	43,934	686,798
18,042	287,788	300,564	83,262	" 13	589,452	37,650	25,112	37,442	689,656
18,083	14,104	309,311	85,039	" 20	340,111	36,092	24,905	25,429	426,537
18,122	15,789	313,465	84,983	" 27	364,141	29,157	19,892	19,179	432,359

† Including Exchequer, Savings Banks, Commissioners of Nat. Debt. and Div. Accounts.

Journal of the Royal Statistical Society

SERIES A (GENERAL)

PART II, 1951.

STATISTICS IN CRIMINOLOGY

By M. GRÜNHUT

[Read before the ROYAL STATISTICAL SOCIETY January 24th, 1951, The PRESIDENT,
PROFESSOR A. BRADFORD HILL, D.Sc., Ph.D., in the Chair]

1. *The Beginnings of Criminology and Criminal Statistics*

THE study of human behaviour is one of the many branches of knowledge which have much benefited by the recent development of scientific statistics. In psychology and sociology a growing application of statistical methods made it possible to extend the empirical basis of investigations and to achieve higher standards of accuracy. In criminology a scientific study of crime almost coincided with the beginning of criminal statistics. Questions of crime and punishment have too often been a subject of personal predilection and prejudice, where solutions were sought not with a view to the facts as they are, but as they ought to be according to speculative ideas and moral judgments. Our traditional penal system has as its basis still something of the Benthamite conception of a man being motivated by the balance between the pleasure he expects from the intended offence and the pain he fears from the impending punishment. Bentham, however, for all his rationalistic generalizations, was a strong believer in empirical observation. When the Penitentiary Bill of 1778 provided for regular statistical returns by the Governors of the intended new penal establishments, Bentham (1778) claimed that he had already begun "sketching out a plan for a collection of Bills of Delinquency with analogy to the Bills of Mortality", though—so he expected—"a little more accurate". Such Bills of Delinquency would be of "excellent use to the legislator", "a political barometer", and should be published in the *Gazette* and printed once a year as a book. The practice of collecting regular returns from criminal courts began in connection with the new forms of public administration which emerged after the French Revolution. It originated in France in 1803. In England, from 1805 to 1856 tables of trials at Assizes and Quarter Sessions were regularly printed as Parliamentary Papers (*Criminal Statistics* (1928), Introduction). In 1827, Peyronnet, Chief of the Paris Police, published the first detailed presentation of French criminal statistics, covering the year 1825. When on February 28th, 1828, Sir Robert Peel moved in the House for a Select Committee to inquire into the increase of criminal commitments and the state of the Police in London, he recommended that "admirable" work to the attention of all those interested in such questions "either in the House or in the Criminal Courts" (*Hansard* (1828), New Series, 788). From 1834, Samuel Redgrave published abstracts of these statistics. In 1857, under the direction of Earl Grey, he edited the first comprehensive publication of *English Criminal Statistics*, covering the year 1856. Police, court and prison returns were combined and issued by the Home Office as Part I of the annual *Judicial Statistics*. In the last decade of the century, simultaneously with the Gladstone Committee on Prisons, another Departmental Committee was appointed to revise the Criminal Portion of the *Judicial Statistics*. Their Principal Report of 1893 combines a critical assessment of the methods of criminal statistics with a comprehensive survey of the crime situation in England (*Judicial Statistics*, 1893). It was followed by a Final Report of 1895 and a Supplementary Report of 1899, and

determined the form of a separate issue of criminal statistics for England and Wales up to the present time.

A scientific evaluation of the accumulating material began in the thirties of the last century, that first "era of statistical enthusiasm". It was Adolphe Quetelet, Belgian astronomer and mathematician (Quetelet, 1831, 1836), and the French lawyer, A. M. Guerry (1833), who resorted to statistics in order to base the study of crime on a solid foundation of empirical observation. For this purpose they deliberately adopted methods from physics and mathematics which had proved so successful in the rise of modern science and technology. Quetelet called his *Study on Man* a "*physique sociale*", Guerry claimed to attain "*une certitude complète*", and the historian of the French Revolution, Jules Michelet, even asserted, "the science of nature and the science of justice are one and the same". Thus, "chance, only a veil for our ignorance" (Quetelet), was to be eliminated, and the multiform phenomena of social life reduced to simple unalterable laws. Those early criminal statisticians were indeed impressed by the regularity and persistence of contemporary crime. Guerry found in France every year the same number of people charged with criminal offences, the same order of frequency among the particular crimes committed, and the same distribution of offences with regard to season, region, sex, age, weapons used and other accompanying circumstances. This might have been a true reflection of the stable years of the French Restoration. For Quetelet it was the effect of an "iron budget of crime" in which, as in the monetary budget of the Treasury, the expenses are fixed for mankind, but must be paid in terms of prisons, fetters, and the scaffold. Even when Guerry worked out a comparison between crime in England and France, he used 16 years of English and 22 years of French statistics, not to trace any characteristic trends throughout those periods, but only to compute yearly averages for the design of maps indicating the relative intensity of crime rates in different parts of the two countries.

Unlike this first generation of criminal statisticians, modern criminologists have shifted their interest from static conditions to dynamic processes (Sellin, 1950a). For this purpose criminal statistics are expected to provide the material for following up the rise and fall of crime through certain periods and for establishing correlations between the crime curve and other trends in the social and economic life of the community. There are some relevant observations in the studies of English statisticians of the mid-century. J. Fletcher, strengthening his case for general education by a resort to criminal statistics, reviewed the number of criminal commitments throughout some 20 years, and found a positive correlation between the number of commitments for simple larceny and larceny by a servant and the rise and fall of wheat prices (Fletcher, 1849). John Clay, however, the Prison Chaplain, surveying prison commitments to Preston Gaol, 1824-54, found an increase in the number of convicted prisoners in "good times", which he explained by "the intemperance which high wages encourage among the ignorant and sensual" (Clay, 1855). A significant contribution once more came from Belgium. Its author was E. Ducpétiaux, Inspector-General of Prisons, and one of the classic advocates of the Pennsylvanian system of separate confinement, then on its triumphal way over the whole Continent. In a statistical study of the economic distress in Flanders he maintained that the depression of 1845 had brought to light facts which only confirmed his experience with prisoners on the close connection between crime and poverty; when in the course of six years the number of poor nearly doubled, the total of arrests increased more than twice and the number of prison commitments almost four times (Ducpétiaux, 1850). Such evidence led the Nestor of German statisticians, Georg von Mayr, to the observation that in the Bavaria of the sixties every sixpence in the rising price of rye made one man per 100,000 steal and another emigrate to the New World (von Mayr, 1867).

We know to-day that a much more complicated index is necessary than the price of one staple commodity. The level of wages, the rate of unemployment, the purchasing power of money, are only some elementary factors among many others which determine the pressure to which the community, or certain groups within a wider community, are exposed. The results of studies by Dorothy S. Thomas (1925) have been generally accepted; she established a tendency of robbery and house- and shop-breaking to increase in bad times and to decrease in good times. But this is a tendency only. Covering a large number of years one may get a negative correlation of .75 between the crime curve and the economic trend. Even in years when rising crime coincides with an economic decline, the reaction of the crime curve varies to a considerable degree; in Germany, both the breakdown of the currency in 1923 and the unemployment crisis of 1932

1951]

coincided with an increase in crime; but while in 1923 theft rose by 300 per cent., in 1932 it only rose by 17 per cent. (Warner, 1934; Schwarz, 1938.).

2. *Social Studies in Criminology*

Methods of Approach and the Statistical Implications

At the beginning of the twentieth century social studies came into their own by the development of new methods designed for the study of human behaviour. Psychology at last succeeded in overcoming the narrow nineteenth-century concept of a study of human consciousness, and shifted the emphasis from the cognitive to the volitional, and from the conscious to the unconscious aspect of the mind. Social case studies tracing individual life histories, with special emphasis on personal conditions and social background, reflected a new approach of the social worker in relying on experience based on personal relationship. A new field opened for an extension of knowledge about human life, and an insight into the significance of personal relationships. By collecting a sufficient number of case studies of a comparable type, recurrent data can be coded and statistically evaluated. It is a way of combining individual observation with numerical assessment similar to the method applied by Booth for his London Survey.

This recent departure proved most fruitful for Criminology, but it involved new problems for a statistical treatment of the data regarded as relevant for the specific purpose of investigation. In one way or another the criminologist is faced with the alternative of either aiming at an accurate statistical evaluation of a few objective data collected from a vast number of cases, or focusing on such intangible factors as personal reactions and mutual relationships, which require an intense study of a small manageable sample group and are ultimately based on the investigator's discretionary judgment. The study of successful or unsuccessful social adjustment of former probationers may serve as an illustration. There has been a huge American survey of nearly 20,000 probation cases from 24 probation areas within 16 states and the District of Columbia. The investigators distinguished between probationers whose order was revoked, and those who were discharged; within a three-year period, and recorded their characteristics with regard to race, age, marital status, recidivism, type of offence, and regular employment. The result was that—at the time of the American depression—employment was the most significant factor; probation was revoked in the case of nearly every third totally unemployed probationer as against only 7 per cent. of fully employed probationers (*Attorney General's Survey*, 1939). What is to be gained from such investigations is a solid foundation of a common experience rather than a new insight into causes of crime and the forces making for social adjustment. If one wants to study the significance of personal relationship within the family rather than its size or completeness, of the attitude towards work rather than the mere fact of being employed, of psychological reactions besides intellectual abilities, one must analyse a small number of perhaps no more than 100 elaborate case histories. In this case, however, the investigator is confronted with an almost infinite number of variations and combinations of symptoms, that no one case seems to be comparable with any other, and an attempt to express qualitative differences by a numerical assessment threatens to level down those individual characteristics on which the investigation has been centred. These are two extreme instances, but they illustrate the two ends of the scale between which every particular criminological research plan has to determine its place in accordance with the specific aims of the investigation.

In many of such studies the criminologist needs advice with regard to statistical methods applicable to small numbers. Since the growing interest in the human factor makes discretionary judgments indispensable, means must be sought to reduce the subjective element in the assessment of the basic data of the inquiry. The field workers should therefore be a small and homogeneous group, constantly in contact with the centre of the investigation. They should be trained to give always the facts from which they derive their judgments. Questionnaires and record sheets may adopt the contrast method, directing the fieldworkers' attention to either of two exclusive characteristics: faithful or unreliable, alert or indifferent, balanced or aggressive.

The Horizontal Approach

There have been three principal lines of approach in the statistical evaluation of case studies. The first one is the horizontal approach, a comparison of a representative sample group of

delinquents with a non-delinquent control group. The classic achievement of this type of research has been Sir Cyril Burt's *Young Delinquent*, which first appeared in 1925 and still maintains its place as a leading authority. One of the main effects of this book was the general recognition of the "multiple causation" of crime which rules out the search for any alleged single cause. Numerous personal and social factors are found at a higher rate among delinquents than among non-delinquents, but almost none of them failed to appear in a certain proportion of non-delinquents. While an answer to the question of what in the end leads a potential delinquent into actual crime cannot be found by statistical considerations, Sir Cyril Burt goes as far as a numerical assessment can go in contributing to the explanation of delinquency. By totalling the number of typical conditions which according to his observations are assumed to be manifest among 100 delinquents and 100 non-delinquents, he finds the average delinquent burdened with nine factors while his non-delinquent contemporary would only be faced by three. On the qualitative side, the conditions of delinquency with the highest coefficient of correlation are defective home discipline (.55), inborn instincts (.53), and emotional instability (.46). If the major, or preponderating, factors are singled out, the most significant ones, manifest in more than every second case of delinquency, are, on the environmental side, family conditions and companionship, and on the personal side mental dullness not amounting to mental deficiency, and temperamental instability not amounting to a psychopathic personality (Burt, 1925).

Numerous studies followed this pioneer work in a horizontal approach to the conditions and symptoms of juvenile delinquency. A more recent investigation undertaken at the London School of Economics supplements the original findings by extending the field of observation from London to provincial towns. One of its striking results is that while delinquents come more frequently from broken homes than non-delinquents, there is an even more marked difference in the proportion of children with an unsatisfactory parent-child relationship among delinquents and non-delinquents both coming from complete, "unbroken" families. This is indeed the outstanding difference between the delinquent and the non-delinquent groups of that survey; the chance of a delinquent coming from a home where parents are over-strict or over-indulgent is three to four times as great as the chance of a delinquent coming from a home with a satisfactory attitude of parents to children. Thus statistical evaluation supports the re-emergence of the human factor in criminology (Carr-Saunders, 1942).

The Ecological Approach

The second line of approach is the ecological one. Statistical evaluation of criminological data is intended to determine the crime rates for different localities. The idea of such a geography of crime is not new. Guerry's *Statistique morale en Angleterre comparée avec la statistique morale de la France*, (1864), contained a number of maps indicating the intensity of crime in various districts of both countries, and the Departmental Committee of 1893 added similar maps to the Principal Report. The growing use of case studies and the extension of fieldwork has brought criminological research nearer to the scene of crime and environment of criminals, and thus led to a new topography of crime within smaller communities. Sir Cyril Burt's book contained a map indicating the different density of juvenile delinquency in London. Clifford Shaw did much valuable work when in 1929 he first mapped out the areas of a different intensity of juvenile delinquency in Chicago, radiating from the slums. He extended his investigations to other American cities (Shaw, 1929, 1931). Recently, similar "sociogeographical" maps have been designed for West Berlin, where the Zonal boundaries seem to be the storm centres (*Sozialgeographische Karten* (1950)). To-day a topography of juvenile delinquency and other adverse social conditions has its place in the social preparation of town planning. These ecological crime studies are almost by definition static; they compare places, not periods. And yet, they may indicate a dynamic process. Maps referring to different periods may show characteristic changes; or a continuity in the topographical distribution of crime may be due to anti-social activities of different subsequent groups of inhabitants. In Clifford Shaw's investigations the Chicago slums appear to maintain their excessive crime rate throughout 30 years, and within this period they saw successive waves of new immigrants, first from Ireland and Germany, then from Poland and the Balkans, and recently coloured people from the American South. Ecological crime studies reveal not only the persistence of certain social conditions in a given locality, but also the selective processes of adaptation and emancipation.

1951]

The Vertical Approach

The third approach aims directly at the investigation of these dynamic processes of social maladjustment and re-adaptation. It is a vertical approach, intended to follow up the careers of criminals throughout certain periods of their lives. Again, the idea itself is not a new one. "Katamnese" have always been an indispensable part of medical research, and sometimes attention has been drawn to the after-careers ("*Spätschicksale*") of former criminals, delinquents, and prostitutes (von Grabe, 1923). Such vertical research has recently been brought to a high degree of perfection by the sustained effort with which Sheldon and Eleonor Glueck (1930, 1934, 1937, 1940, 1943) devoted the better part of their work for more than 25 years to the study of two groups of 500 young inmates of the Massachusetts State Reformatory and 1,000 juvenile delinquents before the Boston Juvenile Court. Both groups were followed up by intense case studies throughout three consecutive five-year periods, and the results submitted to a thorough statistical evaluation. The effect of these formidable studies was not only a shock for administrators of penal and corrective institutions, since the close following-up revealed a much higher reconviction rate than the official statistics, but it has also affected the principal outlook on crime in human life. Seen in the wider setting of a longer stretch of the offender's life the crime committed is no longer an isolated act for which we seek the cause, nor is punishment a separate entity in its success or failure to be judged by a subsequent court appearance alone. Crime and juvenile delinquency are often preceded or accompanied by other symptoms of social maladjustment, and the process of social adjustment may go on, even in spite of temporary relapse into criminal activities; some of those who are reconvicted for fresh offences may exhibit less serious forms of criminal activities, or even show a marked improvement in work habits, family relationships, or fulfilment of economic obligations. Social adjustment is a process of attaining maturity—often a belated and retarded maturity. According to the Glueck's figures the years between 31 and 35 are the "great divide"; the contribution of this age-group to the number of reformed men in the second follow-up period was 2·3 times higher than in the first period, while the average increase in the number of reformed men from the first to the second period was but 1·3 (Glueck, 1945). Social maturation, however, is not a question of the chronological age alone. It needs a certain time from the beginning of the individual's criminal career. The Gluecks found that a child who begins with criminal behaviour at an age of 9·7 has the best chance of giving up crime at an age of 18·5, while the juvenile offender starting at 14·9 has the highest average success rate at 25·8 (Glueck, 1945).

There is no preference for one of the three forms of approach. They are aiming at different aspects of a complex phenomenon which will never be completely comprehended by one single method alone. Only by supplementary contributions from various angles shall we be able to come nearer to truth and understanding. In a comprehensive criminological research the horizontal, ecological and vertical approach have all to play their parts in explaining crime as a behaviour of individuals or groups within space and time.

At the moment certain consequences of the vertical approach claim the special interest of criminologists. In the United States the experience gained by follow-up studies has been utilized for the purpose of crime prediction (Monachesi, 1950). The follow-up studies show that a number of personal factors, social conditions and past experience are typical symptoms of offenders who after a certain penal or corrective treatment revert to crime again. It should therefore be possible on the strength of prevalence of such symptoms to forecast the future criminal careers of fresh court cases. There have been various methods applied to transform this simple statement into a reliable scientific instrument. The most elaborate scheme is the crime prediction tables worked out by the Gluecks themselves. They not only enumerated indiscriminately a large number of crime symptoms, but weighed and selected certain specific factors of a high significance for a criminal future. Out of 60 correlation factors they selected only 5 or 6 with a high prediction utility, and weighed these selected factors according to their degree of relevance. With regard to post-treatment recidivism of juvenile offenders such factors are, e.g., parental discipline, retarded school attainments, conduct at school, early beginning of misbehaviour, time-lag between onset of delinquency and clinical observation. Each of the selected factors was subdivided according to a two-, three-, or four-point scale (e.g. parental discipline: good, fair, bad), the respective percentual rate of recidivism established for each sub-group (juveniles with good, fair or bad parental discipline), and finally the totals drawn of the highest and of the lowest percentual

rates of recidivism in the sub-groups of all 5 or 6 selected symptoms. These two sums of the highest and of the lowest percentage figures throughout the selected symptoms are a numerical expression of the limits indicating the highest and lowest possible crime risk for an accumulation, or an absence, of relevant crime conditions. The difference between that maximum and minimum is divided into four score groups, and the percentual crime risk for each score group computed and inserted in a crime prediction table. The prediction table therefore indicates the crime risk of an offender on the strength of the scores assigned to him.

Professor Glueck himself was able to verify his prediction methods by an application *ex post*. He investigated a group of former civilian offenders who had been reconvicted for military offences, and found that 85 per cent. of them were such a bad crime risk that they ought never to have been conscripted, and that a further 10 per cent. exhibited still a crime risk of 50-60 per cent. (Glueck, 1945). Other critics observed that such prediction methods yielded reliable results in the extreme groups, determining the very good and the very bad risks, but left too large a medium group, the bulk of doubtful cases, to be of great help for decisions on the conditional release of prisoners (Trunk, 1937).

It is a legitimate purpose of criminology to make the experience gained from an analysis of past criminal careers available for courts and parole boards, as there is dire need of empirical material on which to base their decisions in the best interest of prevention of crime and the reformation of the offender. The American prediction tables are a bold effort to provide such guidance in a concise and expedient form. American criminologists would be the last to assert that their methods allow for more than risks and probabilities, or that the contemplation of these risks should be the only consideration for the sentencing court. All they insist on is that those who make a decision and those who carry it out as probation officers or members of an institutional staff know, as accurately as we are able to tell, what they are doing, and see the reasonable prospects as well as the odds against which they have to struggle. There are, however, two further comments to make. First, it has rightly been observed that statistical prediction methods have generally been applied to forecast the behaviour of a group, and to determine the proportion of the probable conforming and deviating conduct within the group. Crime prediction, however, undertakes to predict the future behaviour of an individual. It is still an open question whether we are justified in deciding on a man's destiny by assuming that because he exhibits symptoms like those of a group out of which 80 per cent. are persisting in crime, he himself has a chance of 4 to 5 to belong to the 80 per cent. persistent criminal and not to the 20 per cent. who become straight. The second objection refers to the time factor. Selection and weighing of symptoms for crime prediction are to be based on past experience. In the meantime, treatment methods are changing no less than the social conditions into which the prisoner is expected to return. Unless prediction methods constantly keep pace with contemporary training facilities, rate of employment, costs of living, etc., it can hardly be justified to assess a man's future prospects by a resort to the experience gained with treatment methods and under social conditions which belong to the past.

In England, treatment research, another outcome of the vertical approach, is at present much in the forefront of criminological planning and discussion. We are in search of the offenders' differential response, of the reaction of different offenders to various forms of treatment. For this purpose, the behaviour of offenders at a certain time after the conclusion of their penal and corrective treatment is to be correlated with their personal conditions and social background on the one hand, and the particular form of treatment on the other. This object differs from crime prediction in emphasis rather than in matter. It is not so much to establish ascertainable probabilities of success or failure after a certain treatment as to gain a deeper insight into those complicated processes by which man reacts to certain stimuli, accepts, returns, or rejects trust and confidence, shoulders or evades responsibilities, faces reality squarely or tries to escape from it. All this is inadequately covered by a metaphorical use of the medical term of treatment and by the sociological concept of adjustment. For any such research, the mode of treatment, in respect of which the offender's reaction shall be tested, should not be accepted as a constant factor, but is in itself a subject for discriminating investigation. Probation, with or without residential control or mental treatment, Attendance Centre, Approved School, Borstal, Youth Prison, Training Centre and so forth are legal and administrative categories, differing to a certain extent in the intensity of deprivation of liberty and the effects on the offender's social status. As

1951]

far as the offender's reaction is concerned, many other factors are relevant, such as the probation officer's case load, the inmate-staff ratio in an institution, the question of whether an institution relies on the formative effect of a well-administered routine, or puts the emphasis on a personal effort of the staff in their work with individual offenders. For the purpose of such treatment research, one may trace the history of former probationers and ex-prisoners who are living to-day either as law-abiding citizens or are still anti-social or criminal, or else one may start with fresh cases and accompany them with a consistent record of regular subsequent case studies. Perhaps one day such regular forms of social accounting will become a routine function of the administration of criminal justice. In the meantime, considerable obstacles have to be overcome. In the fieldwork it will be difficult to collect sufficient evidence on the post-treatment conduct of a representative sample group of former offenders without doing harm to their self-confidence and reputation by a fresh reminder of their past encounter with the law. At the same time, in treatment research the difficulties facing a statistical evaluation of relevant data are even greater than in other investigations of material taken from case studies. The desirable detailed knowledge of the specific response of individual offenders to particular forms of treatment requires a thorough analysis of very elaborate case studies. The size of the sample group must therefore remain moderate. In any educational research, subjective judgment on human qualities and personal relationships is less avoidable than in studies on crime causation. Finally, the number of variables on both sides of the relevant correlation is even greater; in addition to the manifold personal and social conditions of the offender there is the variety of possibilities on the treatment side which make a tremendous difference for the individual probationer, trainee, or prisoner, and are for this very reason an essential element in any realistic research. It is hoped that more will be done in this topical version of the vertical approach. It cannot be too difficult to make existing practical experience available for such research plans. There is the probation officers' experience attained by this characteristic way of "extra-mural" treatment and often given as evidence before the sentencing court; there are the recommendations of the Classifying Schools, and of the Allocation Centres for Borstal training and corrective training, which can be checked by comparison with the experience made in the institutions of the offenders' final destination; and there is the valuable material of individual Borstal reports plus after-care reports of the Borstal Association. From a survey of such existing material valuable conclusions will be drawn for the organization of new fieldwork for the immediate purpose of research undertaken simultaneously with the treatment of the offender.

This brief survey of criminological research past and present indicates the important function of statistics in the creation and further progress of scientific studies on crime and punishment. Criminology is indeed deeply indebted to modern statistics, but the demands for further statistical help and co-operation are far from being exhausted. In order to support this proposition, the discussion which follows deals with some general observations on the significance of statistics in criminology.

3. Published Criminal Statistics

An Appreciation of Crime Trends

Criminal statistics are a regular feature of the administration of justice in all civilized countries. They give a fair indication of the crime situation of our time. In England the total of persons found guilty of criminal offences has decreased notably since the beginning of the war; this, however, is due to a drastic fall in non-indictable offences, including violation of traffic regulations; the indictable offences, the hard core of crime, have increased conspicuously (Table 1). This recent rise in indictable offences only accentuates the general trend of crime for the last fifty years. As Table 2 indicates, apart from a temporary decrease during the first world war, which was possibly a "technical" decrease only, the rate of crime known to the police has steadily increased since the beginning of the century. Two things seem to be characteristic of this development; first, the continuous and more and more accelerated rise in burglaries and cases of breaking and entering, the main offences under the group crimes against property with violence, and secondly, the steep rise in the numbers of juveniles found guilty of indictable offences. Before and during the war juvenile delinquency increased at a higher rate than adult crime, while the inflated post-war criminality of the higher age-groups rose more steeply, but fell also more notably than the

TABLE 1

Number of Persons found Guilty of Criminal Offences

	<i>Non-indictable Offences</i>		<i>Indictable Offences</i>	<i>Total</i>
	<i>Traffic Offences</i>	<i>Other than Traffic Offences</i>		
1938	475,124	233,895	78,463	787,482
1945	148,419	149,019	115,974	413,412*
1948	326,130	201,436	129,384	656,950*
1949	320,182	203,381	114,294	637,857*

* Excluding offences against Defence Regulations.

TABLE 2

Crimes Known to the Police per 100,000 of Population

<i>Annual Average</i>	<i>All Indictable Offences</i>	<i>Crimes of Violence against Persons</i>	<i>Crimes against Property with Violence</i>	<i>Crimes against Property without Violence</i>
1878-82	373·87	7·88	25·88	324·17
1883-87	328·85	7·26	23·12	281·26
1888-92	293·25	6·63	22·42	248·21
1893-97	270·64	6·97	25·89	221·34
1900-04	255·67	5·95	28·15	205·55
1905-09	285·72	5·93	35·15	227·16
1910-14	269·56	5·47	33·82	211·52
1915-19	251·00	3·65	30·43	204·10
1920-24	279·99	3·52	45·42	215·37
1925-29	324·87	4·56	52·19	248·97
1930-39	568·46	5·83	97·37	440·78
1940-44	865·60	7·53	140·21	683·67
1945-49	1,126·45	10·94	252·30	811·28

Jud. Statistics, 1897, Part I, 24. *Crim. Statistics*, 1927, 32; 1930, 20; 1934, 20; 1948, 17; 1949, 17.

curve of juvenile delinquency (Table 3). At the same time, as a consequence of the sinking birth-rate, the population aged 8 and under 17 had already begun to decrease while the older age groups were still increasing (Table 4). It would be interesting to extend these historical considerations and to trace the trend of criminality throughout longer periods. Such studies might be a welcome contribution to social history, and provide an answer to the often repeated question as to whether on the whole crime has, or has not, increased with the spread of modern civilization. A mere statistical survey, however, would not serve this purpose. With length of time the figures of criminal statistics become less comparable. Efficiency of the police, practice of the courts, legal definition of the offences and the methods of recording have changed, and this makes a comparison of past and present figures misleading. Great care must therefore be taken in the interpretation of statistical results of the past. An historical analysis has to rely on fluctuations of crime as they have been put on record and to compare them with the more recent trends, but should not draw ill-founded conclusions from a comparison between sets of figures from distant periods.

With due regard to these reservations it may be fair to say that while there is an upward trend in burglary and house- and shop-breaking, there have been, since the end of the last century, temporary fluctuations in crimes of violence against the person (Table 2). This comes out more

1951]

clearly if the two crimes of murder and wounding are singled out (Diagram I). While there is a steady and drastic increase in wounding throughout the last twenty years, the murder curve shows a number of vacillations, and the recent post-war increase in murder appears to be a peak of moderate size within a downward trend. Taking a wider view, one gets the impression that during the first part of the nineteenth century crime in England was increasing; 1811-41 the rise in crime was noticeably in advance of the growth of the population, with two temporary falls in 1821-23 and at the time of the Reform Legislation (Fletcher, 1849). The year of 1843 has been described as the turning of the tide, with a marked fall throughout three consecutive years (Redgrave, 1846). There was a considerable decrease in serious offences against property in 1871 which an official "Memorandum respecting the Decrease in Crime in England and Wales" (*Accounts and Papers*, 1872) ascribed to the beneficial effects of recent legislation against habitual criminals (Habitual Criminals Act, 1869 Prevention of Crimes Act, 1871). The Departmental

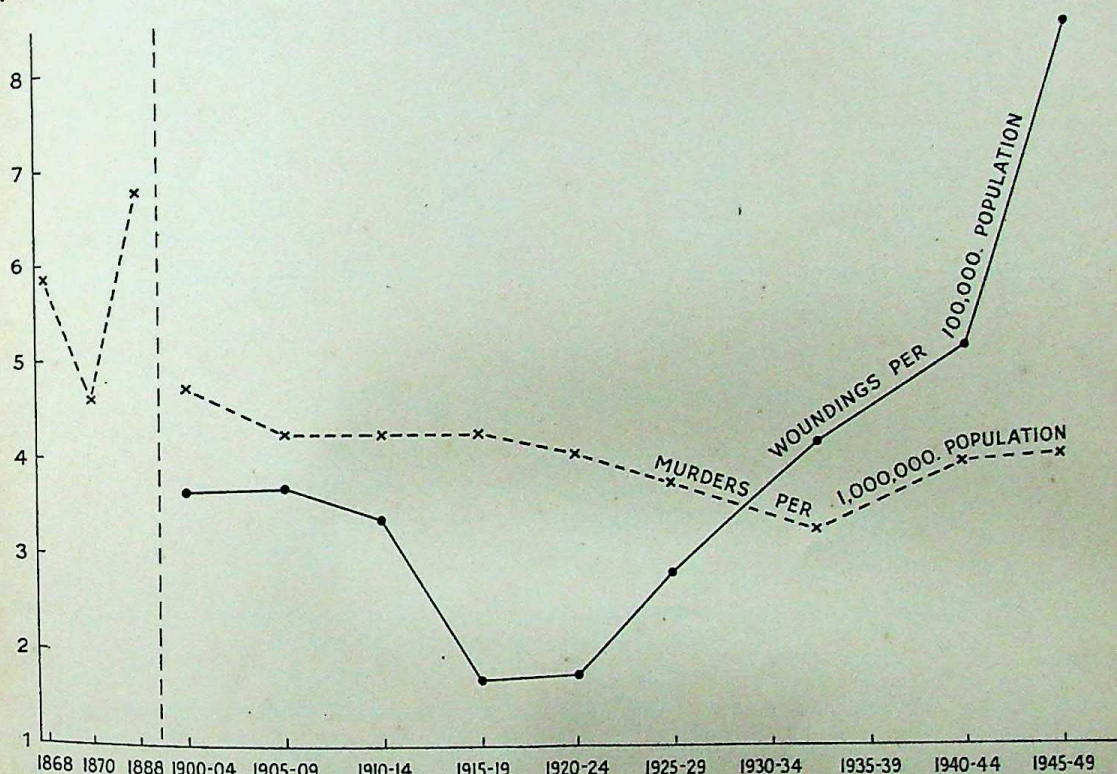


DIAGRAM 1.—Murders and woundings known to the police. Rates per 1,000,000 of the population.

Committee (1893) noted a downward trend from 1874 and a marked fall from 1883, interrupted by two smaller peaks in 1888 and 1893, and that happened during two decades in which the English population was continuously increasing (*Judicial Statistics*, 1893). When the Boer War began in 1899, the number of crimes known to the police was down to the record figure of 239 per 100,000 of the population, and there was a somewhat higher low-tide on the eve of the first world war. The rise of crime in the year of the general strike, 1926, continued in 1927, and the total in 1928 was still above the standard of 1925 (*Criminal Statistics*, 1928, p. v).

As in England, in most other countries the war and the immediate post-war years were accompanied by a marked rise in crime. According to material collected by the Social Commission of the United Nations' Economic and Social Council, this increase took place mainly in the sphere of offences against property, Canada, Australia and certain South American Republics being the exceptions. In most countries the increase was more marked in the smaller numbers of convicted women than in the larger numbers of men. As one might have expected from statistical considerations, the rise was steeper among first offenders than among recidivists, and to a certain

extent the increased volume of crime appeared to be due more to criminal activities of hitherto law-abiding citizens than to repeated offences of recidivists (United Nations, 1950). In English prisons the number of first-offenders rose from 7,363 in 1939 to 9,470 in 1947, while the number of ex-convicts, i.e., prisoners who had served a sentence of penal servitude before, sank from 1,011 to 951.

TABLE 3

Juveniles, Adolescents and Adults found Guilty of Indictable Offences

	<i>Juveniles</i> 8 and under 16	<i>Adolescents and Adults</i> 16 and over	<i>Totals</i>
1930	11,995	44,771	56,766
1934	17,902	47,834	65,736
	8 and under 17	17 and over	
1938	28,116	50,347	78,463
1944	40,554	65,996	106,550
1948	44,434	84,950	129,384
1949	40,430	73,864	114,294

Crim. Statistics, 1934, XXV; 1939-45, 15-18; 1948, XXI and XXV; 1949, XXVII and XXXI.

TABLE 4

Number of Populations in Two Age-Groups

	<i>Population aged</i> 10-16	<i>Population,</i> 16 and over
1930	3,804,680	29,514,850
1934	4,135,000	30,410,500
	<i>Population aged</i> 8-17	<i>Population aged</i> 17 and over
1938	5,694,300	30,986,900
1949	5,003,000	33,213,000

Crim. Statistics, 1935, XXVII; 1949, XXVIII and XXXI.

All European countries shared a drastic increase in juvenile delinquency, with steep jumps in the first years of the war and a recurrent post-war peak (*War and Juvenile Delinquency*, 1, 1947). In some of the former enemy-occupied countries the latter was, at least partly, a "technical" peak, and more the effect of the resumption of normal police and court services than a result of new outbreaks of lawlessness. In England the post-war peak occurred in 1948, and it was of an unprecedented and so far unexplained magnitude (Table 3). Recent investigations in Austria have suggested that the inflated war and post-war juvenile delinquency is not so much an increase in the total volume of crime as a premature manifestation of criminal activities which in normal circumstances might have occurred in a higher age-group. A comparison between the distribution of ages among male thieves in Vienna in 1937 and 1946 indicates that the peak age has shifted from 20 to 17 years; while the new peak of the boys in 1946 was moderately higher than the former peak of the adolescents of 20, the latter went down to the level formerly held by their contemporaries of 22½ years of age (Reimer, 1949). This has a criminological significance in so far as, according to statistical experience, the proportion of recidivists increases with the earlier beginning of criminal activities (Grassberger, 1946). This Austrian phenomenon has no parallel in English experience. The age distribution among English offenders in 1938 compared with the

1951]

record year of 1948 indicates an additional volume of crime in every age group. The increase among juveniles is the most significant as it started at an already formidable level (Diagram II). The Diagram has been drawn on the basis of the official figures, without splitting the larger units of higher age groups into two-year periods. The actual curve would therefore be more flattened in the higher age groups, but the official figures show in an expedient way the characteristic high crime rate of the school-leaving age.

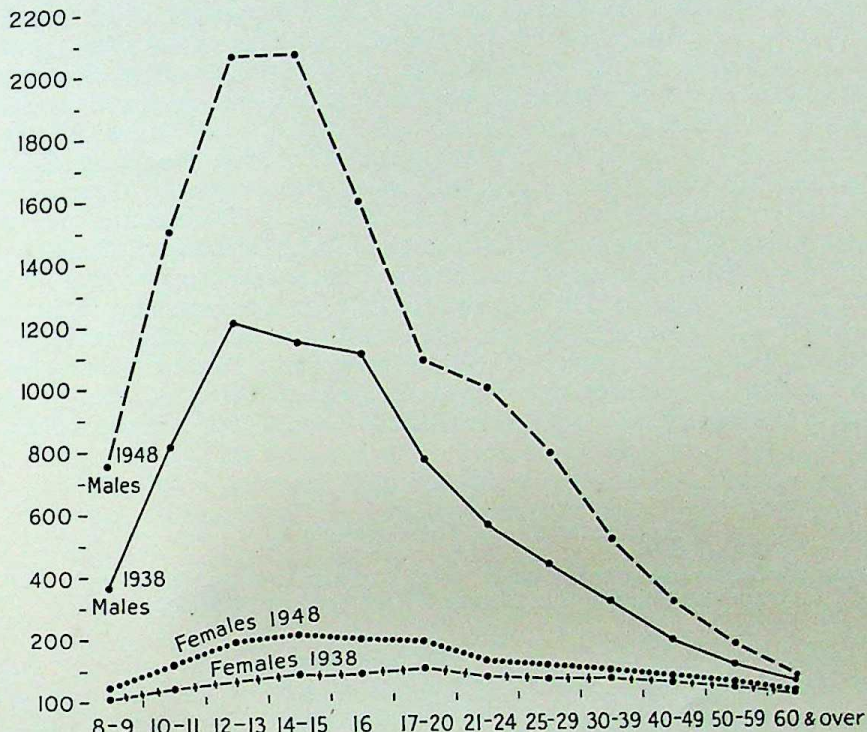


DIAGRAM 2.—Proportions of males and females found guilty of indictable offences per 100,000 of the respective age-groups, 1938 and 1948.

As a reflection of the increased volume and the more serious character of crime, the English prison population has doubled since before the war. While in 1938 the daily average prison population of convicted persons in England and Wales was 9,966, it reached 17,908 in 1948. Up to and including 1946 this rise in the number of prisoners was due to longer sentences rather than to an increased number of convicted prisoners. The number of men received on conviction even sank slightly from 28,815 in 1938 to 28,331 in 1946, when the daily average population of convicted men had already risen to 13,221. In the following year, 1947, the receptions rose to 31,116 men and the population to 14,448. This development is an obvious effect of the marked increase in indictable offences within a smaller total of convictions all round. The percentage of indictable offences among convicted male prisoners rose from 48.7 in 1938 to 76.6 in 1947 (*Report Prison Commissioners, 1948, p. 11*). This had its effect on the sentencing practice of the courts: in 1939 out of 27,965 convicted prisoners 1,355 had sentences of more than 12 months, and in 1947 out of 31,144 convicted prisoners 4,769 had to serve sentences of more than 12 months (*Report Prison Commissioners, 1939-41, p. 156; 1948, p. 117*).

The Limitations of the Data

Criminal statistics have their obvious shortcomings. The principal source of error is the "dark figure", i.e. the difference between the number of crimes committed and the number of recorded crimes which have been tried at the courts, or have otherwise come to the knowledge

of the authorities. The "dark figure" cannot be ignored or neutralized, because it is by no means constant. It is relative to the type of crime and criminals, the strength and efficiency of the police, the changing attitude of the public in their inclination to report suspected crimes and to prosecute alleged offenders, and finally to changing methods of recording complaints made to the police. Unless the strength of the police force is constantly adapted to the volume of crime, the proportion of undisclosed crime is bound to increase with the high tide of criminality. In England the police is slowly recovering the ground lost by the end of the war. For the whole country, the percentage of indictable offences cleared up had sunk from 50 per cent. in 1938 to 43 per cent. in 1947 and 1948 and rose to 47 per cent. in 1949. The Metropolitan Police reached in 1949 a record of 31 per cent. of all indictable offences cleared up, the highest proportion ever attained since adequate crime records have been available (*Report, Commissioner Metropolitan Police, 1949*, p. 48). In the orbit of the Metropolitan Police, every fourth case of house- or shop-breaking, more than three out of four cases of crimes against the person, nearly all cases of larceny by a servant or fraud, but only 17 per cent. of cases of bicycle-stealing and only 10 per cent. of larceny from vehicles are being cleared up. The rest is the "dark figure" in respect of the return of the Criminal Courts. Even these relative figures relating to certain particular offences may change in the course of time. While the percentage of cases of house-breaking cleared up rose from an annual pre-war standard 1933-38 of 10.4 to 18.6 in 1949, the corresponding figure for robbery sank slightly from 54.0 to 49.0, and for larceny of motor vehicles rather markedly from 70.8 to 44.2. The last-mentioned offence is a good illustration of corresponding and divergent fluctuations in the number of crimes known to the police, percentages of cases cleared up, and persons brought before the courts (Table 5). While in 1946 the high tide of motor thefts coincided

TABLE 5

Larceny of Motor Vehicles

Number of cases known to the police, with percentage of those cleared-up by the Metropolitan Police within their orbit, and number of persons tried.

	<i>Number of Cases known to the Police</i>	<i>Percentages of Cases cleared up in the Metropolitan Police District</i>	<i>Persons Tried Before the Courts</i>
1935-39	1,889	1934-38	70.8
annual average		annual average	
1940-44	1,431	1939-45	58.5
annual average		annual average	
1945	3,714		1,149
1946	5,171	40.4	1,567
1947	4,138	49.8	1,437
1948	2,904	47.7	967
1949	2,806	44.2	1,000

Crim. Statistics, 1949, 3, 7, 10; Report Commissioner Metropolitan Police, 1949, 50.

with a low proportion of cases cleared up and a low rate of court cases, the recent decrease in thefts coincided with a slightly decreasing proportion of cleared-up cases, and with a rise in the rate of court cases. Obviously no indication can be given of the "dark figure" in respect of certain types of offenders. When, in 1949, out of 114,294 persons found guilty of indictable offences, 53,006 were under 21 years of age, and when during the war, in 1942, out of 14,625 persons found guilty of breaking and entering, 10,512 were under 17 (*Criminal Statistics, 1949*, p. xxvii), the question arises, how far this difference is due to a higher criminal proclivity of youth, and how far to the fact that young beginners in crime are more easily caught than older criminals. The growing recognition of the Juvenile Court as the competent agency to deal with wayward youth has more and more strengthened the inclination of the public and the police to bring cases before the court (*Criminal Statistics, 1934*, pp. xiii-xv). In all countries the women's share in

1951]

the total of crimes committed is disproportionately small; the relation between women and men found guilty varies in different countries at a ratio of 1 to 5-10 (Hacker, 1932). It is again open to question whether this divergence is entirely due to less actual crime, or also to less discovered and less prosecuted offences.

The impact of the "dark figure" with the inevitable errors in conclusions drawn from criminal statistics is due to the fact that the usual units enumerated are too far from the source, i.e., the commission of the offence. With every further stage in the process of criminal administration the "dark figure" increases and the figures obtained become less symptomatic of the actual crime position. Crimes known to the police, persons arrested, charged, tried, convicted, and prisoners received in penal establishments are a regressive scale in the representation of the volume and forms of crime. Thorsten Sellin, who has done much to work out a reliable crime index, has shown that in England from 1900-1924 the total of persons committed to prison amounted to 0.47-1.09 per cent. of the number of crimes known to the police, and the persons convicted to 55.1-68.3 per cent. However, even within one and the same legal system the relation between these different crime indices is not a constant one. While in Cleveland the number of offences reported rose from 7,067 in 1922 to 11,968 in 1929, the number of arrests sank from 2,658 or 37.6 per cent. to 2,490 or 20.8 per cent.; in Baltimore, however, the number of offences reported sank from 6,486 in 1923 to 4,650 in 1930, but arrests rose from 1,696 or 26.1 per cent. to 2,431 or 52.3 per cent. (Sellin, 1931). Such inconsistencies are increased if the legal qualification of the criminal acts concerned is to be determined by different authorities at various stages of the procedure. A comparison of the homicides reported to the police, disclosed by the Coroner, and tried before the courts, is a good illustration of this diversity (Table 6). These figures are not directly comparable, as the police reports crimes, the Coroner victims, and the courts refer to persons tried. They seem, however, to indicate a difference in qualifying homicide as murder, with the proportion of homicides assumed to be murder decreasing in the order of Coroner, police, court.

TABLE 6

Homicide

Number of cases reported to the police, number of victims according to coroners' inquest, and persons charged or tried before the Courts.

	<i>Cases Reported to the Police</i>	<i>Victims Established at Coroners' Inquest</i>	<i>Persons Charged or Tried</i>
1856		(a) 205 (b) 271 <hr/> 476 (c) 6	(a) 82 (b) 282 <hr/> 364
1878	(a) 159 (b) 254 <hr/> 413	(a) 170 (b) 166 <hr/> 336 (c) 4	(a) 59 (b) 224 <hr/> 283
1897	(a) 122 (b) 183 <hr/> 305	(a) 135 (b) 160 <hr/> 295 (c) 2	(a) 63 (b) 199 <hr/> 262

(a) Murder. (b) Manslaughter. (c) Justified homicide.
(Computed from *Judicial Statistics*.)

For these reasons the number of crimes known to the police, as the nearest possible approach to the source, has been generally recognized as the best available index of the volume of crime. England has a long tradition in this field; from 1857 figures have been regularly published not only of the total number of indictable offences known to the police, but also of certain groups of offences. This precedent has been followed by Finland. In France the enumeration is limited to the total of crimes known to the police; in Canada this method applies to towns of over 4,000 inhabitants only. In the United States over 1,000 police authorities have volunteered to submit reports to a central agency. When in 1947 the Division of Social Activities in conjunction with the Statistical Office of the United Nations sent out questionnaires to Member States, only in a small number of countries statistics of crime known to the police or prosecuting authorities were available; they were Belgium, Canada, Denmark, Finland, France, Iraq, and—for more recent years—the Union of South Africa. Even this method of getting to the source as near as possible is neither perfect, nor does it serve all legitimate purposes. Dr. Mannheim, in his critical analysis of English Criminal Statistics, has shown that in the course of time the "dark figure" in the yearly police returns is far from being constant; attitudes both of the public and of the police, standards of the degree of suspicion required, methods of recording and tabulating undergo considerable changes and thus prohibit a comparison of such figures over longer periods (Mannheim, 1940). The main weakness of the police returns is that, for obvious reasons, they eliminate altogether the person of the offender. Whenever juveniles, adolescents and adults, or men and women, or first-offenders and recidivists are relevant, the resort to court statistics is indispensable.

The difficulties in neutralizing the "dark figure" make a plausible case for an attempt to go even farther than police returns, and at least to supplement statistics of crimes and criminals by a statistical assessment of the victims. This device has successfully been applied in studies of homicide. In this particular field vital statistics give reliable data of the victims without the hazards of legal distinctions between murder and manslaughter, which differ considerably from country to country. On this basis, Roesner assessed three zones of different homicide-death rates in Europe, lessening by degree from an Eastern zone of the states bordering on Russia and the Balkans to a Central and Mediterranean zone, and finally to a North-Western zone with Eire as the country with the lowest homicide-death rate. According to this same study, the rate in the United States is ten times higher than in England (Roesner, 1937). In a similar way, L. F. Hoffmann has shown that in American cities the homicide mortality has increased from 2.1 per 100,000 of the population in 1900 to 8.5 in 1924 (Hoffmann, 1926). These attempts suggest that valuable information might be gained for the trend of offences against property, if the material collected by Insurance Companies for the calculation of their policies could be made accessible for criminological research.

Traditional criminal statistics represent the classic conception of crime and punishment. They focus on crime as an isolated act followed by an equivalent punishment. There have been no outstanding changes in the principal way of presentation for the last 70 years. However, for this the statisticians are not to be blamed, nor is it due to the indifference of criminologists, but it is the fault of a virtue; in statistics, uniformity throughout longer periods is necessary to make successive publications comparable, and for this continuity perfection has sometimes to be sacrificed. Even with this qualification, more attention should be given to the personality of the offender and the antecedents of the offence. England is the only country in Europe which does not distinguish in the official criminal statistics between first-offenders and recidivists. Only the annual Reports of the Prison Commissioners refer to this distinction as far as prisoners received on conviction are concerned. This caused a considerable gap in the evidence when the recent Criminal Justice Bill, 1938/1947, was under consideration. In Scotland criminal statistics differentiate between persons not convicted before and those convicted 1, 2, 3, 4-10, 11-20, and more than 20 times. A similar problem is presented by the criminal gang. This is a social phenomenon with a high criminological significance, differing in the case of juveniles and of adults. At the same time the numerical relation between offences and offenders is statistically important to clear up, at least partly, the difference between the number of offences known and offenders tried. Italy and Finland present data indicating how many offenders have been convicted for more than one offence; Sweden distinguishes between offenders acting alone or together with others ((German) *Kriminalstatistik*, 1930).

Even in ideal circumstances criminal statistics offer a preliminary orientation only. They

1951]

have been compared to a language of consonants only which needs the addition of vowels to be understandable (G. Tarde). Statistical information directs the attention to certain relevant aspects, but it demands an interpretation on the basis of extra-statistical experience and certain general assumptions. In criminology, statistical information often indicates the direction for further etiological research. In an already remote investigation it had been found that 50 out of 100 boys of an industrial school in Southern Germany were in one way or another mentally abnormal. Does this mean that heredity is the cause of every second case of juvenile delinquency? In that particular case further examination revealed that only with regard to 22 of those boys the anti-social behaviour could be explained by their mental abnormality, and only with regard to 11 of them was their unsatisfactory crime-producing mental state due to parental drunkenness or abnormality. Thus the incidence of the hereditary cause of delinquency was reduced from 50 to 11 per cent. (Gruhle, 1912). The causal link itself could not be established by mere statistical means, but was to be determined by a personal judgment based on a thorough examination of the individual case.

Statistical correlations are not by themselves sufficient to establish causes of crime; they imply the further question: causation or selection? We find high delinquency rates in slums. Are slums breeding criminals, or are they attracting and keeping "low-grade" people and "problem families", who notoriously have many delinquents among their numerous children? Perhaps here are products of a negative selection exposed to crime-producing conditions. Among all children from broken homes the highest delinquency rates are exhibited by children whose parents are divorced, or separated by the desertion of one spouse, especially when the child stays with a parent who is living with a person to whom he or she is not married. Again the question arises whether such a disrupted home is a crime-provoking environment, or whether such conduct is typical of low-grade parents bound to have anti-social offspring. An answer to these questions can only be given by a resort to individual case studies. On the basis of comprehensive factual knowledge such a solution must rest on a well-informed, though ultimately personal judgment.

For considerations of these problems a statistical handling of the collected case studies helps to sort out the typical and the non-typical cases. The typical cases are being used to illustrate the general propositions put forward in the particular criminological study. Even more significant are the non-typical cases. William Healy was right when he claimed to throw a "new light on delinquency" by studying the non-delinquent (Healy and Bronner, 1936). For this purpose he studied the case histories of children from families where at least one of the children had been a delinquent. This was a refined method of using a control group, though by choosing the non-delinquent brothers and sisters of delinquents he eliminated the differential environmental factor in order to concentrate on the personal aspect of crime causation. In the use of exceptional cases it is the unexpected failures, the most disappointing cases, which show the strength of negative factors even in the face of hopeful conditions, and it is the unexpected success which reveals the positive forces at work even against serious odds and a bad crime risk. We find, e.g., that in cases where probation ended in a failure in spite of good family relationships, the probationer had to be certified as M.D., or could not withstand her own dangerous instincts under the pressure of extreme poverty and her father's illness. Or, in the reverse case when probation proved successful in spite of unsatisfactory family relationships and undesirable emotional reactions, there was a successful mental treatment or a fortunate response to a probation officer or a headmaster. From a theoretical point of view it might be possible to establish a correlation between certain personal traits of probation officers and characteristics of probationers bound to lead to a successful response. Practically, however, the numbers available are much too small in view of such almost infinite variations. The desirable case load of a probation officer is 50 to 60. There remains, therefore, an element of chance, of personal destiny, which is involved in the meeting of people.

The time-factor presents a further difficulty in the application of statistical methods to a study of human behaviour. In follow-up studies and treatment research we evaluate factors statistically which have occurred, and were recorded, at different times. The criticism of crime prediction was based on this consideration. It is, however, no less a problem even in a less ambitious treatment research. The material for relevant follow-up studies must be collected and classified with regard to a certain period, e.g., two years after the termination of treatment. Any such time limit is arbitrary. Life goes on, and an immediate success within the test-period may become in

the end a late failure, while an early failure may at last prove a final success. These considerations strengthen the case for repeated successive follow-up investigations of the same sample group for which the research work of the Gluecks remains the outstanding example.

4. *Problems of International Comparability*

Criminal statistics ought to have an international outlook. It is in this field that the great *desideratum* remains. Nearly a hundred years ago Guerry undertook the first comparative studies. To-day we are not so much interested in comparing the crime situation of one country with conditions in another country, but we want to broaden our empirical basis beyond national frontiers. Crime and delinquency are a general human problem, a common feature of all nations, which calls for a constant mutual exchange of experience. Legal studies on criminal law are mostly limited to a particular national legal system, and are only beginning to extend into the sphere of comparative studies. Criminology, however, is an international science which has as its subject a particular aspect of man's behaviour in society, wherever there are societies which have enough in common to allow the experience gained to be inserted into a comprehensive universal picture.

Two main difficulties have so far impeded the progress of criminal statistics in the international field. The first is the difference in the collection and presentation of the statistical material in the different countries. It follows from a Survey, undertaken in 1930, that while all nations give the total of convicted persons, only 20 count persons accused or on trial as well. All but one (Siam) give the sexes, all but two the ages of offenders, but only 5 the marital status, and only 3 the economic position ((German) *Kriminalstatistik*, 1930). The second obstacle is even more relevant. Present national legal systems differ so widely, that similar statistical results in different countries may have an entirely different meaning if correctly interpreted as objective crime indices. In the countries of Western civilization the vast bulk of actions prohibited by law and branded as criminal offences is more or less identical, with certain marginal deviations near the outward frontiers of illegal conduct. Adultery is a criminal offence, though very rarely punished, on the Continent, but it is not an offence in England; untrue sworn evidence, given by negligence, is a criminal offence in Germany, but not in Austria. More relevant is it that in a number of the United States, certain forms of prostitution are punishable which in Europe are outside the sphere of criminal law, while in England being found drunk in public is a criminal offence. In criminal statistics, however, not only the aggregate total of crime committed, but the numbers and percentages of particular offences are recorded. Considerable differences exist in this respect. All countries divide intentional homicide into a serious and a less serious offence. In English law the definition of murder is much wider, and the recognition of a lack of criminal responsibility much more restricted, than in any other legal system, while manslaughter comprehends the privileged case of killing under gross provocation as well as causing death by negligence. In Continental legal systems, cases of deceiving are under one criminal offence (*escroquerie*, *Betrug*), while in England some of them are regarded as a special type of larceny, viz. larceny by a trick, and others form the particular offence of obtaining goods or money by false pretences. It is not substantive law alone that influences the results of criminal statistics. Much depends on the intensity of prosecution, on whether there is, or is not, a public prosecutor with an exclusive function or even a mandatory obligation to take action whenever any suspicion arises. There may be a higher rate of convictions under the more rational Continental rules of evidence, while the English law of evidence goes a long way to protect the accused. In addition, Continental laws concede, but English law refuses, the prosecutor a possibility of appealing against acquittals.

These deep-rooted diversities explain why progress has so long been retarded, not only in the international field, but also in federal states. Federal states with a common Criminal Code like Canada and Germany have been able to build up uniform criminal statistics, but the United States with their 48 different State Jurisdictions and Legislatures still present an unsatisfactory situation in criminal statistics in marked contrast to their advance in criminology. Apart from prison statistics and from by no means complete Juvenile Court statistics, there have been from 1930 the so-called Uniform Crime Reports, submitted by Police Agencies to the Federal Bureau of Investigation. They refer mostly to urban areas, and cover one-half of the population. Only

1951]

from 1932 to 1946 the Bureau of Census collected Judicial Criminal Statistics, but within this short period the numbers of states covered varied widely from at least 6 to at most 30 out of the 48 States of the Union. On the recommendation of the Wickersham Report on Law Observance and Enforcement, 1931, the National Conference of Commissioners on Uniform State Laws have been preparing a Draft Uniform Statistical Act which shall be submitted to the separate state legislatures. No such Act seems to have reached the Statute Book so far. Even this is an attempt to achieve a uniform system of statistics on the basis of divergent substantive criminal law (Sellin, 1950b).

In the international field Quetelet himself was the first to raise the issue at the first International Statistical Congress in Brussels, in 1853. The long-drawn history of these efforts falls into three periods. The first one is the uncritical period, when the case for international criminal statistics was put forward with more enthusiasm than critical methodical considerations. Demands were made for polyglot texts, for data on recidivism and on pardons, and for an increasing number of inquiries into criminological facts, more from the point of view of what might be desirable to know than what was suitable for statistical computation.

The second phase began with a methodical statistical approach, made by Yvernès in Paris in 1889, and by M. L. Bodio at the Vienna Session of the International Statistical Institute. They squarely faced the statistical problems which had to be tackled: an agreement on the subjects which should be counted, a re-defining of statutory offences to make clear which crimes correspond with one another in different legal systems, and an agreement on the method of statistics to apply. The aim of this period was a comparative interpretation of the assembled data of national statistics. A remarkable effort in this direction was Augusto Bosco's attempt to combine studies in comparative criminal law with comparative statistics, and thus to make clear the exact orbit of human action to which the data of each individual statistical system refer (Bosco, 1899).

The third period has been initiated by a vigorous new approach by R. B. de Roos (1928). In his paper at the Cairo Conference of 1927/8 he abandoned the idea of comparing single data, and outlined a study of characteristic trends as they are indicated by an interpretation of the single national statistics within their own legal system and social frame-work. This principle implies in the international field the shifting of emphasis from static conditions to dynamic processes which has characterized many aspects of recent criminological research. Not the volume of crime in general, or the rates of particular offences, are to be compared, but any conspicuous trends manifested within the national system itself; rise or fall of crime throughout longer periods, increase or decrease of juvenile delinquency, shifting weight from acts of violence to offences of dishonesty, from simple stealing to sophisticated frauds and so forth. This is the same method by which in one single country the long-range trend of crime can be established. Such historical investigations too are comparative studies, substituting time for space as the basis of comparison. In other comparative studies, in law as well as in religion, the search for comparable single elements has been replaced by an investigation of more comprehensive subjects, such as the small variety of solutions to basic social problems, or of ultimate answers to fundamental questions of individual life.

This new concept of comparative statistics gave a fresh impetus to international co-operation. From 1930 to 1939 a Joint Committee of the International Statistical Institute and the International Penal and Penitentiary Commission worked out a scheme for practical work in the international field. Two definite proposals were made; a special inquiry should be made into the statistics of intentional homicide, and a model plan should be forwarded to each government with the request to compile statistics in conformity with the model plan for the purpose of international comparison. The practical implications of this project did not much differ in principle from some of the suggestions made fifty years before by Yvernès and Bodio. They referred to a General Introduction, to be prefixed to the annual national Reports, in which the statistical methods applied should be described and the concepts and the machinery of the law explained. For the intended international comparison, the basic units should be persons found guilty by a final judgment. Out of 22 items found in 40 national systems of statistics, seven were adopted for the model plan: sex, age, marital status, nationality, occupation (9 groups), size of place where offence committed, and recidivism (Schäfer, 1936).

The war brought these plans to an end before any practical outcome could have been expected. After the war the Joint Committee was reconstituted, following a resolution of the 25th Session

of the Institute in Washington in 1947. In the following year, however, the Social Affairs Committee of the United Nations resolved to pursue studies in criminal statistics as a necessary contribution to their comprehensive working programme on prevention of crime and treatment of offenders. The initiative in the question of international criminal statistics has thus shifted to this United Nations' agency, and the Institute will take action only if its expert co-operation is explicitly requested (Circular, U.N. Committee on Study of Prevention of Crime). In 1950 the Social Commission of the United Nations' Social and Economic Council published a Statistical Report on the State of Crime, 1937-46 (E/C.N. 5/204; February 23rd, 1950). A number of critical observations have been made in this Report on classification of offences, and especially on the difficulties of establishing comparable data for so complex, and yet so topical, a subject as juvenile delinquency. It has been suggested, that both the Social Commission and the Statistical Commission should ask the Secretariat "to proceed with the task of drafting basic classification of crime and minimum standards for the compilation and the presentation of criminal statistics" (E/C.N. 5/204; p. 27). At its fifth session, May 8th-17th, 1950, the Statistical Commission accepted that suggestion and recommended it to the Secretary-General (Ec. and Soc. Council, V, 11th Session, Suppl. 4, p. 12).

5. Conclusion

This brief account of statistics in criminology has been intended to indicate the contribution of statistics to the rise of a scientific criminology—the aims and possibilities of statistical research on crime and its treatment, but also the difficulties encountered, the present gaps in our knowledge, and the inherent limits of the application of statistical methods. Statistics, by definition, is "an exact research into those aspects of life which are susceptible to numerical treatment" (Lexis, 1911). Crime and punishment have certain of such aspects, but they have other important aspects as well. It was the aim of this discussion to determine that dividing line in respect of a number of present-day criminological problems. The objectivity, and because of that, the scientific character, of criminology depends on a clear apprehension of that line. This objectivity will never be attained by applying accurate statistical methods to data which by themselves do not allow a merely quantitative enumeration. It is an objectivity—the objectivity in social sciences (Max Weber, 1904, 1922)—of squarely facing and frankly revealing the indispensable personal element.

References

- Accounts and Papers*, 36, Vol. L (Session 1872), 179.
Attorney General's Survey of Release Procedures (1939), 2, 353.
 BENTHAM, J., (1778) *Works*, ed. Bowring, (1843) 4, 29. Edinburgh: Tait.
 Berlin, Magistrat von Gross-Berlin, Hauptamt für Gesamtplanung. *Sozialgeographische Karten* (1950).
 BOSCO, A. (1899), *Bull. Inst. Int. Statist.*, 9, liv. 2, 52.
 BURT, C. (1925), *The Young Delinquent*. University of London Press.
 CARR-SAUNDERS et al. (1942), *Young Offenders*. Cambridge University Press.
 CLAY, J. (1855), *J. Statist. Soc.*, 18, 74.
Criminal Statistics, England and Wales. London: H.M.S.O.
 Departmental Committee on Criminal Statistics, Principal Report. *Judicial Statistics*, 1893. London: H.M.S.O.
 DUCTÉIAUX, E. (1850), *Mémoire sur le pauperisme dans les Flanders*. Brussels: Hayez.
 FLETCHER, J. (1849), *J. Statist. Soc.*, 12, 168.
 GLUECK, S. and E. (1930) *Five Hundred Criminal Careers*. New York: Knopf.
 — (1934) *One Thousand Juvenile Delinquents*. Harvard University Press.
 — (1937) *Later Criminal Careers*. New York: Commonwealth Fund.
 — (1940) *Juvenile Delinquents Grown Up*. New York: Commonwealth Fund.
 — (1943) *Criminal Careers in Retrospect*. New York: Commonwealth Fund.
 — (1945) *After-Conduct of Discharged Offenders*. London: Macmillan.
 GRABE, E. VON (1923), *Archiv für Kriminologie*, 75, 171.
 GRASSBERGER, R. (1946), *Lösung kriminalpolitischer Fragen durch die mechanische Statistik*. Vienna: Springer.
 GRUHLE, H. (1912), *Ursachen der jugendlichen Verwahrlosung und Kriminalität*. Berlin: Springer.
 GUERRY, A. M. (1833), *Essai sur la statistique morale de la France*. Paris: Grochard.
 — (1864) *Statistique morale en Angleterre comparée avec la statistique morale en France*. Paris: Ballière.

1951]

- HACKER, E. (1932), *Monatsschrift für Kriminalpsychologie*, 23, 276.
Hansard, Parliamentary Debates, Official Report. London: H.M.S.O.
HEALY, W., and BRONNER, A. (1936), *New Light on Delinquency*. Yale University Press.
HOFFMANN, L. F. (1926), *Annals American Acad. Political Sci.*, 125, 20.
Judicial Statistics, England and Wales. London: H.M.S.O.
Kriminalstatistik, Berlin.
LEXIS, W. (1911), *Statistik*, in *Handwörterbuch der Staatswissenschaften*, 3rd ed. Jena: Fischer
MANNHEIM, H. (1940), *Social Aspects of Crime in England*. London: Allen & Unwin.
MAYR, G. VON (1867), *Statistik der gerichtlichen Polizei in Bayern. Beiträge zur Statistik des Kgr. Bayern*.
MONACHESI, E. D. (1950), *J. Crim. Law and Criminology*, 61, 268.
QUETELET, A. (1831), *Penchant au crime*. Brussels: Hayez.
— (1836), *Sur l'homme, ou Essai de physique sociale*. Paris: Bachelier.
REDGRAVE, S. (1846), *J. Statist. Soc.*, 9, 177.
REIMER, P. (1949), *Juristische Blätter*, 71, No. 23. Offprint.
Report of the Commissioner of the Police of the Metropolis (1949). London: H.M.S.O.
Report of the Commissioners of Prisons. London: H.M.S.O.
ROESNER, E. (1937), *Monatsschrift für Kriminalpsychologie*, 28, 46.
ROOS, R. B. DE (1928), *Bull. Inst. Int. Statist.*, 23, liv. 2, 762.
SCHÄFER, E. (1936), *Bull. Inst. Int. Statist.*, 29, liv. 3, 240.
SCHWARZ, H. (1938), *Int. Rev. Soc. Hist.*, 3, 334, 379.
SELLIN, T. (1931), *Monatsschrift für Kriminalpsychologie*, 22, 577.
— (1937), Research Memorandum on Crime in the Depression.
— (1950a), II. *Congrès International de Criminologie*. 5. *Rapport Général. Sociologie*, 10.
— (1950b), *J. Crim. Law and Criminology*, 40, 679.
SHAW, C. (1929), *Delinquency Areas*. University of Chicago Press.
— (1931), Wickersham Report on Law Observation and Enforcement, No. 13, II, 23.
THOMAS, D. S. (1925), *Social Aspects of Business Cycles*. London: Routledge.
TRUNK, (1937) *Monatsschrift für Kriminalbiologie*, 28, 209.
United Nations Committee of Special Agencies and International Organizations on the Study of Prevention of Crime and Treatment of Offenders (1948). Note by the Representative of the International Statistical Institute on Criminal Statistics. Unprinted Circular.
United Nations Social Commission, Economic and Social Council (1950), Statistical Report on the State of Crime 1937-46. E/C.N. 5/204.
War and Juvenile Delinquency (1947), *International Child Welfare Review*, 1, No. 2-3.
WARNER, S. B. (1934), *Crime and Criminal Statistics in Boston*. Harvard University Press.
WEBER, M. (1904), *Objektivität sozialwissenschaftlicher und sozialpolitischer Erkenntnis Arch. Sozialwissenschaft*, 19. Reprinted (1922) in *Gesammelte Aufsätze zur Wissenschaftslehre*, 146.

DISCUSSION ON DR. GRÜNHUT'S PAPER

Dr. H. MANNHEIM: It is a great pleasure to me to propose a vote of thanks to Dr. Grünhut. He has given us a competent, concise, and at the same time comprehensive picture of the very many and close relations between criminology and statistics, and where I personally venture to disagree with him it is in emphasis only.

Dr. Grünhut has divided his paper into four main sections—the first, historical; the second, a critical analysis of the main trends in scientific work in the statistical field; the third, the published criminal statistics; and the fourth, international statistics.

I propose to limit myself mainly to the second of these sections, and perhaps to one or two occasional remarks on the third, ignoring the historical and international aspects.

When studying Dr. Grünhut's paper I remembered another occasion in April, 1939, when there was a discussion in this Society on the subject of juvenile delinquency, opened by my colleague, Dr. Rhodes. In his reply he said that a discussion on any aspects of criminal statistics was a rare event in the annals of the Society. True as this is, these comparatively rare events have always been very fruitful, and very much worth while to the criminologist.

Dr. Grünhut himself refers to some interesting work shown in papers read before the Society more than a hundred years ago, for instance, that by J. Fletcher in 1849. It might be interesting for someone familiar with both criminological literature and statistics to make a brief survey of the occasions when criminological problems have been discussed before this Society, not so much to deal with the actual substance, but to find out whether there has been any progress in the application of statistical techniques to criminological problems, and if so how far this progress is reflected in the papers and discussions.

To illustrate what I have in mind, Dr. Grünhut refers repeatedly to the eternal problem of the relation between statistical and individual case studies. This same problem was discussed here in 1939 by various speakers, including Miss Clement Brown and myself, and a very illuminating

reply was made by the then President of the Society, Professor Bowley. It would be interesting to consider the report of that earlier debate on this important problem, and also what has been said about it in Dr. Grünhut's Paper. He says that "the criminologist is faced with the alternative of either aiming at an accurate statistical evaluation of a few objective data collected from a vast number of cases, or focusing on such intangible factors as personal reactions and mutual relationships which require an intense study of a small manageable sample group and are ultimately based on the investigator's discretionary judgment". Later he again refers to "the two ends of the scale, between which every particular criminological research plan has to determine its place in accordance with the specific aims of the investigation".

There has been much progress in this respect within this comparatively short span of twelve years. We now have a better understanding of the relations between the individual case study aspect and the statistical aspect. I might refer to Horst's well-known study published by the American Social Science Research Council, and to the last study of the Gluecks, *Unravelling Juvenile Delinquency*. The Gluecks in more recent years have shifted the emphasis of their research from what Dr. Grünhut rightly calls the vertical approach—the follow-up study—to the horizontal, that is, to the control group study. In their recent book they have produced an elaborate and accomplished example of a control group study, which shows how the various individual case studies and the statistical study can be combined, and where some of the case histories collected for the statistical part of the investigation are subjected to a very minute psychological and psychiatric analysis. Although this has not been sufficient to close the gap between the two ends of which Dr. Grünhut has spoken, it has at least narrowed it perceptibly.

Dr. Grünhut makes certain remarks regarding the prediction problem in the same section of his Paper which worry me a little, but our difference may perhaps be only one of phraseology and not of substance. As he himself has said, the Gluecks have, right from the beginning, stressed again and again that they do not regard their prediction tables as the final solution. They are intended only as a supplementary instrument. But I am not sure whether it is justifiable to say (it is a reference to what other people have said) that such predictions may yield reliable results only at the extremes, leaving a large middle group to which they cannot be applied. Moreover, when Dr. Grünhut says that "statistical prediction methods have generally been applied to forecast the behaviour of a group and to determine the proportion of the probable conforming and deviating conduct within the group [while] crime prediction . . . undertakes to predict the future behaviour of an individual", I should like to leave it to experts to say whether this is actually true of prediction research in general. As I understand prediction research, which has been carried out in many other fields besides crime prediction, for example in the field of education, one of its objects is to predict the likely behaviour of individuals. The same is true in criminological research.

Dr. Grünhut goes on to say, "It is still an open question whether we are justified in deciding on a man's destiny by assuming that because he exhibits symptoms like those of a group out of which 80 per cent. are persisting in crime, he himself has a chance of 4 to 5 to belong to the 80 per cent. persistent criminals and not to the 20 per cent. who become straight". From my many years' experience as a judge in the criminal courts, if I were left to answer this question I should certainly say that it is safer to rely on prediction tables plus individual judgment than on individual judgment not backed by this comprehensive body of experience which is used for the build-up of prediction tables. The other argument to which Dr. Grünhut refers is certainly true, that we have to consider the constant changes going on in the field of treatment, and may have to revise our prediction instrument again and again. In this field no static method is possible.

May I refer in conclusion to the distinction which Dr. Grünhut makes between prediction research and what he calls treatment research. He himself says that it is only different in emphasis. He says, "This object differs from crime prediction in emphasis rather than in matter". But I doubt whether it is even a difference in emphasis. If we study the various publications of the Gluecks and other prediction researches we find that the authors have had this in mind, being aware of this differential response of different individuals. We cannot talk, for example, of prison and probation, because prison and probation may each mean a hundred different things, and each of these may mean quite different things to the individual offender. Therefore, it is not a difference of emphasis, but it is something which has been in the minds of these people all the time.

Mr. T. S. LODGE: I have great pleasure in seconding the vote of thanks to Dr. Grünhut for his most interesting and comprehensive paper.

One is bound to sympathize with him concerning the difficulty of interpreting statistics of crime. Unfortunately it is not easy to see how to obtain a better measure of crime than "crimes known to the police". For homicide it might be possible to make some slight improvement

1951]

(though the room for improvement is probably rather small in this particular field), but such tentative inquiries as I have made have not encouraged me to think that the data in the hands of insurance companies would help much in measuring crimes against property. The difficulty of measuring juvenile delinquency is referred to in the Paper, but it might have been stressed even more. All the obstacles that Dr. Grünhut has mentioned, and a few others as well, are met with in trying to measure juvenile delinquency, and one has to walk very warily when trying to interpret statistics about it. No cross-bearing or alternative approach is to be despised, and it is as well to avoid stating conclusions too positively.

Nevertheless, there is an enormous amount of information contained in the Criminal Statistics volumes and the Prison Commission statistics, and it will be agreed that they are a quite indispensable barometer of the crime situation, even though the calibrations are not always perfectly clear.

I should like to make one small point about the "dark figure". The percentages of crimes cleared up quoted in the Paper for the whole country are worked out ignoring the carry-over from one year to the next: for example, the 1949 figure ignores crimes cleared up in 1949, but committed in earlier years. I think it would be fairer to include these, so that the percentages cleared up become 50 per cent. in 1938, 43 per cent. in 1947 and 1948, and 47 per cent. in 1949. The Metropolitan Police figure already includes these carried-over crimes cleared up.

Statistics relating to recidivism, and describing the offender as well as the offence, are missing from the published criminal statistics of England and Wales, and Dr. Grünhut very properly feels that this ought to be put right. I am glad to say that statistics about previous convictions of criminals are now being collected, and the Criminal Statistics of 1951 will contain some statistics about recidivism.

On international statistics, I agree that differences in legal systems would make a static comparison between the crime figures of different countries rather a doubtful proposition. It seems clear, though, that much is to be learned by the study of dynamic processes side by side with the study of economic and social changes in the countries concerned. I hope the United Nations will succeed in solving all the problems they will meet in getting the figures together.

The Gluecks' research work falls into two parts—a descriptive part and a predictive part. So far as the description of the life history of offenders is concerned, their results are of the greatest interest, particularly in relation to social maturation and the tendency of criminals to reform after a certain period. Their results on prediction, as an aid in selecting penal treatment, I find more difficult to appreciate. It seems to me that a prediction table for use by the Courts can be useful only if it covers several of the different treatments available. The Court wants to compare the probable result of probation, or absolute discharge, with the probable result of, say, imprisonment; and if it is told only that imprisonment will give a 70 per cent. probability of reform it is not much better off.

This is the really serious difficulty in this type of research. It is necessary to examine two similar groups of persons subjected to different treatments, or to find a statistical method which gives an equivalent result. This is difficult for the primary reason that there is, as yet, no way of showing that two groups are similar, or in what relevant and measurable ways they differ, and for the secondary reason that similar groups naturally tend to receive similar treatment in the Courts. I think, therefore, that prediction tables for help in treatment are still a long way off; that the invaluable pioneer work of the Gluecks is, all the same, pioneer work only; and that we are still at a very early stage of the development of scientific research of this kind.

On the general question of the use of prediction tables, Dr. Grünhut points out two difficulties. The first is that the tables may lag behind the progress of events. This objection can no doubt be minimized, as it is in dealing with mortality and sickness tables, by various methods, but the problem is so far in the future that at present I am content to leave it there. Dr. Grünhut's other objection to prediction tables is more important. He says, "It is still an open question whether we are justified in deciding on a man's destiny by assuming that because he exhibits symptoms similar to those of a group out of which 80 per cent. are persisting in crime, he himself has a chance of 4 to 5 to belong to the 80 per cent. persistent criminals and not to the 20 per cent. who become straight". This objection seems to me to overlook the fact that probabilities, expressed or implied, are the basis of most practical decisions. Surely anyone who has the duty of deciding a man's destiny must use all the information he can obtain, and that will include the probabilities worked out in the prediction table. If he possesses information about the individual offender beyond what was taken into account in constructing the prediction table, he should use it as best he can to modify the calculated probabilities. If he has no additional information, then he should follow that course which the prediction table says is most likely to further the end he has in view.

That brings me to Dr. Grünhut's concluding paragraph. It is, indeed, sobering to consider the present limitations of statistics in criminology. There may well be a danger of assuming too readily that existing statistics and statistical methods will solve our present problems. But to

say that particular limitations are inherent in the subject goes, I think, beyond our knowledge. As problems of classification and measurement are solved in the fields of psychology, sociology, and criminology itself, there is every reason to believe that the field of application of statistical methods will widen, and I do not think that at this early stage of progress the boundaries of the subject can rightly be drawn.

MR. RONALD HOWE: I deal with statistics only in so far as they affect the work of the Criminal Investigation Department, New Scotland Yard, of which I have the good fortune to be in charge. Statistics are useful to show us where crime exists. If we do not know where the crime exists we cannot station our detective or uniform officers at points where they should be able to deal with it. I am afraid that until 1933, when we changed our method of recording crimes, the figures published by the police forces not only in England but all over the world were for the most part quite incorrect, so that, with all respect to Dr. Grünhut, any comparison with the 'crime' figures before that time cannot give an accurate picture. Why the police did this it is difficult to say. Perhaps they wanted to present a pleasant picture. But in 1933 we changed it all, and since then most forces, I think, have adopted the same method. But it makes Dr. Grünhut's task very difficult if he wants to get a true picture over the years.

The difficulty as regards crime and the "dark figure" is this. Let us say that in London we have about 100,000 indictable crimes—not including offences such as prostitution. Of those indictable crimes, 95 per cent. are larceny in some form or another, and when we come to the "dark figure", the crimes not cleared up, it is difficult to know how far the figure is correct. Two or three years ago we were following a man for six or seven months. He was a housebreaker in a small way, and he always used the same method. He committed 300 breakings, in our belief, but when caught admitted only 30 or 40, so that we had to record some 260 as not cleared up. Thus it is difficult to arrive at what proportion of crime is cleared up, but I should say that no police force can show more than 35 per cent., or at most 40 per cent. of crimes as cleared up. Higher percentages must be regarded with some doubt.

In the first part of the Paper the author says that "The results of Dorothy S. Thomas have been generally accepted; she established a tendency for robbery, house- and shop-breaking to increase in bad times and to decrease in good times". I cannot agree with that, because our experience shows that a very large proportion of house- and shop-breaking is committed by a small hard core of regular criminals, who get their living by breaking into your house and mine. If we could put away for a time all those expert breakers—say some number under 2,000—I think we should bring the amount of house-breaking and shop-breaking in London down by 30 or 40 per cent. These people are not affected by good or bad times. They are intent on getting what they can. Moreover, a certain number of thieves go to work on the racecourses during the summer, and we find that with the end of the flat-racing season crime in London goes up quite considerably.

I am not quite sure how far we can go on the ecological approach. The strange thing is that we get more crime in the section of London that stretches north and west from the centre than in any other, although the property there is not greatly different from that in other parts. Crime in the East End—and I have in mind the East End before it was blitzed in the war—has always been lower than in any other part of London, and this is not because there is no good-class property further down the East End. Perhaps one of these days Dr. Grünhut may be able to explain the reason.

Slums, of course, promote crime, but I would draw your attention to Los Angeles, which has no slums and is a beautiful city in many ways. There the crime rate *per head* of population, is many, many times what it is in London. Therefore crime does not depend always on slums.

Something was said in the Paper about bicycles. A very small number of bicycle thefts are cleared up—I think only about 10 per cent. The reason for that—and it is of interest as regards statistics—is that the average person who has a bicycle and loses it cannot identify it when it has been found after being stolen.

As regards murder, figures are difficult. In London we do not regard murder only from the point of view of numbers. From that point it is not an important crime; we never get enough of it for statistical purposes. In 1950 the total number of murders in London was 24; this among 8½ million people. Of these murders, five of the victims were newly-born children, and those cases might have been murder or infanticide. I do not think that we have ever had 40 cases of murder in London in a year, or fewer than 15.

One item in the records we keep at Scotland Yard that might interest the Society concerns the files of persons who have been convicted of crime. There are about 1,100,000 files. That means that in this country about one person in 48 has been convicted of crime. If, therefore, you are

1951]

sitting in a bus holding approximately 64 persons, you can be confident that 1½ of your fellow-passengers have been convicted of some criminal offence.

Flight-Lieutenant ROGERS asked the author what work had been done on the difference between spontaneous crime and premeditated crime.

The PRESIDENT asked whether it was not possible to carry out some experiments in treatment of criminals. In medicine long-term experiments were being carried out to determine the effects of treatment on human beings, e.g., to find out whether some of the modern drugs were effective, patients were placed randomly in groups, one group consisting of those who had been given the drug and another group consisting of patients who had received the best treatment possible for the condition apart from the drug. Needless to say close consideration was given in each case to the ethical aspects. He did not know whether it would be possible to do anything like that in crime. Could one in certain instances randomize the treatment given and measure the results? He supposed it was more difficult to do this than it was in medicine, but not necessarily impossible.

Dr. GRÜNHUT expressed his thanks for the appreciation with which his Paper had been received, and for the numerous stimulating suggestions made in the course of the discussion. The point which the President had raised presented a grave issue, viz., the question of experiments in the social sciences, and in particular in criminology. Criminological experiments would amount to this: if two offenders with the same type of personality, and the same social background and past experience, had committed the same type of offence, the Court would put the one on probation and commit the other to prison, and then in five years' time we might see the result of the different treatment of what had been presumed to be equal cases. Dr. Grünhut did not think that such a course was possible. A court of law would never feel justified in ordering any other treatment than that which on the strength of the information available appeared to be the best for the individual offender. Experiments might, however, be possible *ex post*. One could make virtue out of necessity, and use the outcome of the traditional haphazard way of selecting and meting-out sentences as material for comparative investigations. That was what Sir Cyril Burt intended to do before the war when he planned to group together from his sample group of young delinquents "equal cases" with regard to his psychological examinations, and then to follow-up their later careers after the different treatment assigned to them by various courts.

With regard to Mr. Rogers's question about studies on the difference between spontaneous and premeditated crime, he thought that in the evidence submitted to the present Royal Commission on Capital Punishment one might find some material relevant to this problem. The question of what proportion of murders committed and which types of murder are premeditated crimes in the true sense of the word was especially considered in connection with the question of a possible "graduation of murder".

He had been most interested to hear Mr. Howe's account of the Criminal Investigation Department, and very much hoped that the immense treasures of Scotland Yard could be made available for further criminological research. Mr. Howe's reference to the habitual criminal who was, so to speak, "crisis-proof" was particularly interesting. However, changing social and economic conditions affected the "criminal reserve army", and led potential law-breakers into actual criminal activities.

He was sure that Mr. Lodge's announcement that from 1951 English Criminal Statistics would include figures on recidivism would be received with the utmost satisfaction by everybody interested in Criminology. He was also grateful to Mr. Lodge for amending the official figures of the Criminal Statistics for 1949 with regard to the percentages of crimes actually cleared up by the police. On the question of an application of neighbourhood psychology to criminological investigations he would refer to the article on the Group Factor in Crime and Punishment by the Dutch Juvenile Court Judge, N. Muller, in the October issue of the *British Journal of Delinquency*, and to Dr. Mannheim's comments thereon.

He was very glad that Dr. Mannheim and other speakers had taken up the moot point whether we were justified in basing our treatment decisions on crime prediction tables of the type devised by the Gluecks. This issue implied a true question of conscience. We were in a precarious situation today. Dr. Mannheim had pertinently described the traditional "hit-and-miss" method of sentencing which had proved so unsatisfactory in the past. We had therefore been all out for a more reliable way, but when at last a rational instrument in the form of prediction tables had been offered, we seemed to be frightened by the prospect of errors disguised by a pretended accuracy. This dilemma only reflected the terrible burden which judges had to bear in adjudicating and punishing their fellow-men.

As a result of the ballot taken during the meeting, the candidates named below were elected Fellows of the Society:

Durga Prosad Banergee.
Philip Arthur Blight.
Francis Keble Crowley.
Harold Davey.
John Hugo Ford.
Satya Priha Guha.
Amelia Isabelle Harris.
William Hartston.

Evan Innes.
Michael Anthony Gordon Knight.
Leslie Cecil Lauderdale.
Jack Mason.
Gauri Dayal Mathur.
Chandulal Vrijlal Parekh.
Harshadkant Chandulal Parekh.
James Walker.

Corporate Representative

William Arthur Harrison *representing* Humber Ltd.

1951]

DIFFERENCES IN RESPONSE RATES OF EXPERIENCED AND INEXPERIENCED INTERVIEWERS.*

By J. DURBIN and A. STUART,

Division of Research Techniques, London School of Economics[Read before the ROYAL STATISTICAL SOCIETY, February 28th, 1951, the President, Professor
A. BRADFORD HILL, D.Sc., Ph.D., in the Chair]

CONTENTS

1. INTRODUCTION	164
2. GENERAL DESCRIPTION OF THE SURVEY	165
(a) Participants	165
(b) Purpose	165
(c) Subject-matter	165
(d) Scheme	165
(e) Location	166
(f) Scale	166
(g) The sample	166
(h) Compromises	166
(i) Costs	167
3. THE QUESTIONNAIRES	167
(a) Attitudes towards tuberculosis	167
(b) Reading habits	167
(c) Savings	167
(d) Classification	168
(e) The record sheet	168
4. THE INTERVIEWERS	168
(a) Experienced	168
(b) Inexperienced	168
5. THE SAMPLE	169
6. THE EXPERIMENTAL DESIGN	169
(a) Factorial layouts	169
(b) The design adopted	170
(c) Allocation to sample	170
(d) Allocation to interviewers	171
(e) Extra volunteers	171
7. THE FIELD WORK	171
(a) Briefing	171
(b) Interviewing	172
8. THE CODING	172
9. THE MAIN RESULTS	172
(a) Success, refusal and failure to contact	172
(b) Age and sex of student interviewers	179
(c) Number of calls	180
(d) Times of calls	182
10. SUMMARY AND CONCLUSIONS	183

* This paper reports a project in which all members of the Division of Research Techniques co-operated. In particular Mr. S. T. David played a prominent part in planning the inquiry and in the organization of the fieldwork. The project was initiated and supervised in all its stages by Professor M. G. Kendall, Director of the Division.

1. INTRODUCTION

IN recent years there has been a very rapid growth in the use of sample surveys of human populations. The increase has been accompanied by striking developments in the techniques of survey design and by the accumulation of a vast body of practical experience. It remains true, however, that the *representativeness* of a sample depends on the ability of field workers to trace their subjects and to persuade them to co-operate in the completion of a questionnaire; and that the *accuracy* of the results depends on that of the information recorded. Much hinges on the address, skill and tact of the interviewer, who thus becomes a possible source of serious bias in the inquiry. The investigation of the causes and extent of this type of bias and the efficacy of measures taken to eliminate it constitutes an outstanding problem in the field of sample survey research.

The subject is of great importance to professional survey organizations, who are continually faced with questions of the recruitment of field workers, and wish to know how much of their resources can be or should be devoted to the training of investigators. For universities and similar research bodies the reliability of inexperienced interviewers governs the value of most of the work done in this field. In fact, the money available for surveys of a research character is usually so limited in comparison with the cost of field inquiries that such organizations inevitably tend to rely upon volunteer helpers, particularly upon students, for the interviewing part of their work. The question is, how do the results obtained by amateur interviewers of this kind compare with those of professional investigators? The inquiry described in this paper was framed to throw light on this question and some related problems of interviewer performance.

The Division of Research Techniques was formed at the London School of Economics in October, 1949, with the help of funds provided by the Nuffield Foundation. Its primary object is to study those branches of methodology required in the research undertaken by the School. In practice this amounts to a study of the statistical techniques associated with research work in economics, sociology and psychology. It was felt that the problem of the accuracy and reliability of the untrained interviewer was the most urgent requiring investigation, for it affects much of the field-work undertaken in sociology. The essential point may be put quite bluntly: Is the performance of untrained volunteers so unreliable that inquiries conducted by them have little scientific value? Or alternatively, is it so close to the performance of experienced interviewers that with a little instruction they can safely be employed? The whole future of research involving surveys by non-professional institutions depends on the answers to these questions.

It is not suggested that any one inquiry can provide full and final answers. But it was hoped (and events justified the hope) that a properly designed investigation might do much to quantify the issues involved, and to define the more detailed research necessary to determine them.

As has been mentioned, the two main factors governing the accuracy of a survey are, first the representativeness of the sample, that is, the extent to which the individuals interviewed cover the population intended, and secondly, the quality of the information collected. These factors are essentially distinct and can be treated separately, though any overall comparison of the performances of different groups of interviewers needs to take both of them into account. We originally intended to discuss both factors in this paper in the light of the information gained in the inquiry, but the analysis could not be completed in time. The scope of the paper is therefore limited to a general description of the inquiry, together with an analysis of the results relating to the first factor. In practice this amounts to a discussion of the response rates achieved by the different types of interviewers, the circumstances in which interviews were obtained, the reasons for failure and so on. Detailed comparisons of the answers to individual questions are being made and the results will be included in a later report. Meanwhile, if the paper gives an impression of being preoccupied with methodological matters without regard to the quality of the information collected, that must be put down to the separation of publication and not to indifference on the authors' part.

In one respect the Division has been extremely fortunate. The Government Social Survey and the British Institute of Public Opinion readily co-operated in this project in all its stages, planning, execution and analysis. Our grateful acknowledgments are due to Mr. Louis Moss, Dr. Henry Durant and their colleagues for the generous and impartial way in which they have participated in this study; and also to Mr. B. W. Copland, of Research Services, Ltd., who assisted

1951]

in the planning. This report has been prepared by the Division, which takes responsibility for the accuracy of the analysis and the views expressed, but the work on which it is based represents a joint effort.

2. GENERAL DESCRIPTION OF THE SURVEY

(a) *Participants*.—The planning of the survey was carried out by representatives of the Division of Research Techniques, the Government Social Survey, the British Institute of Public Opinion, and Research Services, Ltd. To give a convenient name for use in the field, the composite body decided to call itself the Survey Research Unit, a name which was introduced *ad hoc*, but may perhaps be useful for future co-operative projects of the same kind. The field work, of which more is said below, was carried out by volunteers enlisted from students of L.S.E. and by interviewers of the Government Social Survey and B.I.P.O. Coding and analysis were done by the Division of Research Techniques. This report has been discussed and agreed by the representatives of the three bodies concerned with the field work of the inquiry, but apart from the D.R.T., the representatives associate themselves with it in their personal capacity.

(b) *Purpose*.—As noted in the introduction, the main purpose of the inquiry was to investigate the differences in performance between untrained volunteer interviewers recruited from the students of the L.S.E. and experienced investigators from the two professional organizations.

In addition it was desired to investigate a number of other factors influencing response rate, such as district in which the survey was carried out, subject-matter of the questionnaire, and age and sex of respondent.

These factors are of methodological interest; but there seemed no reason why the inquiry should not at the same time collect information of genuine sociological and economic value. On the contrary there was clearly an advantage in making it as "operational" as possible. The subject-matter of the three questionnaires was therefore chosen so as to throw some light on questions of current sociological interest.

(c) *Subject-matter*.—To provide a sufficiently broad basis of subject-matter underlying the experimental comparisons at least three questionnaires seemed to be called for, representing three distinct types of inquiry. First a short straightforward questionnaire consisting mainly of questions of opinion of a non-contentious character; secondly a more complicated questionnaire, though on a relatively straightforward subject; and finally a questionnaire on a rather difficult subject.

These were the main desiderata from a methodological standpoint. Other competing considerations were the expected value of the findings themselves, apart from their methodological aspects, and the relation of this inquiry to other inquiries on similar topics.

In the event the three subjects chosen were attitudes towards tuberculosis, reading habits, and personal savings. The relevant questionnaires are described below in section 3.

(d) *Scheme*.—Broadly speaking the scheme of the inquiry was to carry out simultaneously three surveys on the above-mentioned subjects, using teams of interviewers provided by each of the three participating organizations. The data were to be collected by the method of personal interview.

The layout of the inquiry was decided according to the principles of experimental design so as to permit all the necessary comparisons to be made with maximum efficiency in the statistical sense. This convenience was not, however, permitted to dominate the operational character of the inquiry; so far as possible normal working conditions were adhered to.

(e) *Location*.—For obvious reasons of convenience the survey was located in London. In an experimental inquiry of this sort little would be gained from attempting to cover a wider area, and the cost of going further afield would have been prohibitive. The inquiry was, in fact, limited still further to three boroughs of London. Three representative boroughs should provide a broad enough basis for the experimental comparisons and should at the same time give results of sufficiently wide applicability in the three component surveys.

The three boroughs chosen were Bermondsey in the S.E., Tottenham in the N.E., and Wandsworth in the S.W. So far as economic groupings of the residents are concerned, Bermondsey is predominantly working-class, Tottenham is mainly working-class and lower middle-class, and Wandsworth is a mixture of working-class and middle-class. All three have fairly stable populations, and were relatively easy of access to the interviewers.

(f) *Scale*.—The scale on which the inquiry was undertaken was governed, as always in survey work, partly by what it was desired to establish, and partly by the resources available. It was eventually agreed that about 1,500 interviews divided equally between the three questionnaires would be sufficient for the purposes of the survey. Each of the three participating organizations agreed to cover a sample of about 500. Details concerning the investigators are given below in section 4.

Altogether about 2,000 names of contacts were allocated, of which 1,512 were arranged in the form of a factorial experiment. It is the results of these 1,512 cases (whether interviews were obtained or not) that form the basis of the analysis in this report.

(g) *The sample*.—The sample was divided equally between the three boroughs. Within each borough a sample of respondents was selected from the National Register by the method of systematic selection (i.e., by choosing a name every so often from the Register). From the information contained in the Register it was possible to obtain the name, address, age and sex (judged from the Christian name) for each individual selected. This information was of very great value in the planning of the inquiry. The nature of the sample is described in more detail below in section 5.

(h) *Compromises*.—Throughout the inquiry an effort was made to keep as close as possible to normal operational conditions. The importance of such an aim in an investigation intended to serve as a guide to practical policy needs no emphasis. Nevertheless it could not always be pursued to the detriment of other considerations, such as the need for ensuring comparability in the results. An example should make the difficulty clear.

The two professional organizations normally use different layouts for their questionnaires, and their investigators are trained with these special layouts in mind. For the student volunteers a third layout would probably be more suitable than either of these. If the purpose of the present inquiry had been merely to compare the successes achieved by the three sets of interviewers in obtaining completed questionnaires, it might have been desirable for each organization to have designed its own questionnaires, once the main features of the contents had been agreed, and to have put them into the field in its accustomed way. This procedure would, however, have made it very difficult to evaluate the relative quality of the material collected by the three organisations. Slight differences in the forms of questions could destroy completely the comparability of the answers obtained. Consequently such a procedure would have necessitated a drastic limitation of the scope of the inquiry.

It was therefore decided to use the same set of questionnaires for all three organizations, even though this might involve slight departures from normal operational practice. For the same reason a common set of printed instructions was issued to the interviewers. On the other hand it was obviously more convenient, and at the same time it was psychologically reassuring, for each of the three sets of interviewers to be briefed by members of their own organizations. As a consequence the briefing meetings were arranged in this way. Members of the D.R.T. were, however, present at all (and of course carried out the briefing of L.S.E. students), so that a high degree of uniformity in the briefing instructions was ensured.

There were several other matters of a similar character. For instance each investigator was called upon during the course of the inquiry to carry out interviews with each of the three questionnaires, whereas in a normal survey only one type would be used during one inquiry. Secondly, an investigator's interviews were in most cases spread over a rather larger geographical area than he would normally be accustomed to. Thirdly, the history of each call was required in rather more detail than is usual. These instances are all discussed at greater length in the relevant sections of the paper; others of a similar nature will also be found.

In the light of the main objects of the inquiry these slight modifications of routine procedures are unlikely to have had much influence upon the validity of the findings. It is possible, however, that they combined to reduce the performance of the experienced investigators to a little below their normal level.*

* Mr. Moss and Dr. Durant have very kindly supplied the following notes on the differences between this inquiry and their normal practice, in so far as they affect the performance of the Social Survey and the B.I.P.O. investigators respectively:—

Mr. Moss: The usual procedures of the Social Survey differ somewhat from the methods used in the

1951]

(i) *Costs*.—Each of the three organizations bore the cost of fieldwork carried out by its own investigators. Of the remaining expenses, the cost of printing of the questionnaires and of the coding, tabulating and analysis was contributed by the Division of Research Techniques, while the Social Survey was responsible for the cost of selection of the sample.

3. THE QUESTIONNAIRES

The three questionnaires are reproduced in Appendices A, B and C. The versions used in the field differed somewhat in layout for ease of handling. It may be mentioned that they were printed in three different colours so as to reduce any confusion between them on the interviewers' part.

No pilot survey was carried out in advance of the main inquiry. The chief reason was that it was found impossible to arrange a time-table including a pilot that was suitable for all three organizations. However, the questionnaires adopted were based on questionnaires that had been tested in previous field surveys, and it was thought unlikely that further tests would have called for much alteration. This supposition was confirmed by experience in the inquiry.

(a) *Attitudes towards tuberculosis*.—This was a simple questionnaire designed to explore the public's attitude towards the causes, incidence and treatment of tuberculosis. No probing or suggestions from the interviewer were allowed.

(b) *Reading habits*.—The reading questionnaire was more elaborate, and called for more patience and skill from the interviewer. Its object was to collect information about people's reading tastes, their opportunities for reading, and the amount of reading they do. It was hoped that the results obtained would be of use to the staff of the London public libraries for the planning of their book service; in particular, thanks are due to the Librarian of Tottenham, who took a keen interest in this part of the inquiry, and made a number of valuable suggestions about the content of the questionnaire.

It has been found in previous book-reading inquiries that many informants are put off by too early a reference to books and libraries. They feel that the subject is beyond them, and protest (often inaccurately) that they don't do any reading. Consequently the questionnaire was begun with simple questions about newspapers and magazines, and the interviewer was requested not to mention books, unless pressed by the informant, until the interview was under way.

(c) *Savings*.—The purpose of the savings questionnaire was to find out the chief factors associated with changes in the various forms of personal savings. The questionnaire, therefore, combined opinion questions with fact collecting. Owing to the complexity of the various forms of savings, the questions about them had to be rather detailed.

The questionnaire began by inviting people to express their opinion on the cost of living and its effect upon their savings. It went on to investigate in detail the two most common forms of

course of this experiment. These differences may affect the results achieved on the side of sampling efficiency and on the quality of the material collected during interview.

So far as concerns sampling efficiency, which alone is dealt with in the report, it may be pointed out that—

(a) Social Survey investigators usually work in their home districts, where it is to be expected that their field planning and interview timing would benefit from local knowledge, and—

(b) Social Survey investigators are trained to do as much interviewing as possible during normal weekdays, and never to force interviews to the informant's dissatisfaction. This may affect the results achieved on the timing of interviews, and the proportion of successful interviews at the first call.

Dr. Durant: From the point of view of B.I.P.O. interviewers the conditions under which they did the work were *normal* for them in the following respects:

1. They were working without supervision in the field and without anticipation of call-backs being made for checking purposes.
2. They were working and being paid on an hourly basis, they telling us the time involved.
3. They were familiar with the layout of the Tuberculosis Questionnaire.

The conditions were *unusual* from their point of view in the following respects:

1. It is seldom that they are given names and addresses of the individuals they are to contact. Mostly the selection of contacts is left in their hands, subject to their quotas, and no re-calls are involved.
2. The layout of the Savings Questionnaire was completely unfamiliar to them.
3. The Savings Survey and the Reading Survey were both considerably longer than the inquiries they usually handle.

saving—Savings Certificates and the Post Office Savings Bank. Since savings are generally made with a purpose in view, some questions were included about any heavy expenditure which the informant may have made during the previous year. Finally, there were two questions on the informant's attitude to the Government's policy of encouraging people to save.

(d) *Classification*.—In addition to the main subject-matter, each questionnaire contained a set of supplementary questions called the *classification*. This part was almost identical for each type of questionnaire, and consisted mainly of questions about the subject's living conditions, occupational and income group, household composition, etc. These questions were based on Social Survey questionnaires, and were sought in order to permit breakdowns by the relevant factors in the analysis. The classification is reproduced in Appendix D.

(e) *The record sheet*.—The special nature of the inquiry called for something more elaborate than a simple list of the names and addresses of the subjects upon which the investigator was required to call. The record sheet that was used for the purpose is reproduced in Appendix E. Its precise form was determined by the need for a detailed record of the time and result of each call made on the subject.

The concentration of the main results of the calls on the record sheet permitted the analysis of these data to go ahead without reference to the questionnaires themselves; there was a considerable gain in time and convenience as a result.

4. THE INTERVIEWERS

The three participating organizations each agreed to cover the same size of sample for the main comparisons that were to be made; with the design adopted this amounted to a sample of 504 each. As it happened, there was a surplus of student volunteers above the minimum requirements, and altogether an extra 549 names for contact were allotted to them.

(a) *Experienced*.—The interviewers provided by the two professional organizations were all experienced part-time or full-time investigators from their ordinary interviewing staff; they were not selected in virtue of any special characteristics or qualifications. Their sex and age distributions were as follows:

TABLE 1.—*Sex and Age Distribution of Experienced Interviewers*

Age		20-29	30-39	40-49	50-	Total
B.I.P.O.	{ M.	2	7	—	3	} 27
	{ F.	6	6	2	1	
S.S.	{ M.	1	1	—	—	} 19
	{ F.	6	5	4	2	

The only detail worthy of note is the predominance of women among the Social Survey interviewers.

(b) *Inexperienced*.—The student volunteers were recruited mainly from students with no examinations in the near future; in fact most of them were second-year students. They were recruited from the general undergraduate body without regard to subject of study, and all volunteers were accepted. There were also included a few postgraduate students and research workers.

The response was excellent, and altogether there were 134 volunteers, of whom 119 took the field. The sex and age distribution of the latter is given below:

TABLE 2.—*Sex and Age Distribution of Volunteer Interviewers*

Age	18, 19	20, 21	22, 23	24, 25	26-	Total
M.	23	36	19	5	10	93
F.	13	7	3	2	1	26

The disparity in numbers between the two sexes is not surprising when one considers that there are about three times as many men students as women students at the School.

Although the students were not paid for assisting in the inquiry, their travelling expenses were covered, and they also received a subsistence allowance of four shillings per day to cover the

1951]

extra cost of food out. No training or instruction was given to any of the volunteers apart from the briefing meetings described below.

5. THE SAMPLE

It is fortunate that we were able to make use of a sample drawn from the National Register; there can be little doubt that the sample so obtained was quite adequate for our purpose.

The National Register and its use as a sampling frame have been described in detail by Gray and Corlett*, so it will be unnecessary to enlarge upon them here. It may be said, however, that the register is intended to cover the entire civilian population domiciled in the country. It is kept on cards which are filed at local food offices. There are two parts to the register, one for children under sixteen, and the other for persons aged sixteen and over. Only the latter part was used for this inquiry.

The samples required were selected separately in the three boroughs concerned by the method described by Gray and Corlett, that is, cards were picked from the register at measured intervals. For each individual selected, name and address and age were recorded; also sex, judged from the Christian name. The selection was made by members of the staff of the Social Survey between three and five weeks before the beginning of the field work.

The samples chosen were rather larger than the exact sizes required, so that at a later stage they could be arranged to give sex and age groups containing equal numbers. This point will be taken up below in section 6(c).

When used in this way, the Register does not, of course, give samples that are properly random in the theoretical sense. In fact with the systematic selection employed here a slight amount of stratification is automatically introduced into the sample. However this small systematic element is unlikely to have had much effect upon the validity of the results obtained.

6. THE EXPERIMENTAL DESIGN

The inquiry was planned in accordance with the procedures developed for the statistical design of experiments, the general object of which is to allow different sources of variation to be investigated in the most economical way. The particular layout adopted was that of a straightforward factorial experiment.

(a) *Factorial layouts*.—A factorial layout is appropriate when a large number of comparisons involving several factors are required, using limited experimental material. Although these designs are very widely employed in other branches of science, little use has been made of them in the field of social surveys. It may, therefore, be worth while to dwell for a time on the underlying principles before going on to discuss in detail the particular design adopted.

These can best be understood by considering a simple example. Suppose that we require to compare the performance of two sets of interviewers, I_1 and I_2 , on two questionnaires, Q_1 and Q_2 . The number of combinations of interviewer and questionnaire is four, namely $I_1 Q_1$, $I_1 Q_2$, $I_2 Q_1$, and $I_2 Q_2$. The sample of respondents is therefore divided into four equal parts at random, and one interviewer-questionnaire combination is assigned to each part. To compare the two sets of interviewers we compare the results of two halves of the sample, one containing the combinations $I_1 Q_1$ and $I_1 Q_2$, and the other containing $I_2 Q_1$ and $I_2 Q_2$. This gives a valid comparison of I_1 and I_2 , since the two halves are identical as regards questionnaire content. In the same way we can compare the performance on the two questionnaires by comparing the two halves of the sample containing combinations $I_1 Q_1$ and $I_2 Q_1$ in the first half, and $I_1 Q_2$ and $I_2 Q_2$ in the second half. This is a valid comparison since the two halves are identical as regards interviewers.

It may be that the difference between the two sets of interviewers is different for the two questionnaires. A measure of this effect, called the *interaction*, is provided by the difference between (a) the comparison of I_1 and I_2 using Q_1 and (b) the comparison of I_1 and I_2 using Q_2 . We can denote (a) symbolically by $I_1 Q_1 - I_2 Q_1$, and (b) by $I_1 Q_2 - I_2 Q_2$. Thus $(a) - (b) = I_1 Q_1 + I_2 Q_2 - I_1 Q_2 - I_2 Q_1$. Since this expression is symmetrical the interaction between interviewers and questionnaires is the same thing as the interaction between questionnaires and interviewers. Their common measure is obtained by comparing the results in the two halves of the sample,

* P. G. Gray and T. Corlett, *J. R. Statist. Soc.*, A CXIII Part II, (1950), 150.

one containing the combinations $I_1 Q_2$ and $I_2 Q_2$, and the other containing the combinations $I_1 Q_1$ and $I_2 Q_1$.

It must be noted that for each of these three comparisons every observation in the sample has been used, that is, each comparison is measured as accurately as if the whole inquiry had been devoted to the evaluation of that comparison alone. Thus a symmetrical layout of this kind allows of great economy in the use of experimental material.

The above example has been concerned with the simplest case of a factorial design using two factors (I and Q) each at two levels ($I_1 I_2$ and $Q_1 Q_2$ respectively), but the method can clearly be extended to any number of factors at any number of levels. In fact the more factors involved the greater the economy in the use of resources, since each observation is used many times over. In all cases the symmetry of the design permits the various effects and interactions to be disentangled in a particularly simple way.

There are other advantages of the factorial design that are not quite so obvious. First of all the analysis of variance and its associated tests can be applied in a straightforward fashion, assuming that the usual conditions of normality, etc., are satisfied, thus facilitating the assessment of the significance of the results. Secondly, each comparison is made over all possible combinations of the remaining factors and levels; consequently the significance of the comparison is much more broadly based than if it had been obtained under a narrow range of experimental conditions.*

(b) *Design adopted.*—The factors investigated in the present survey were as follows:

- (a) Interviewers (3).
- (b) Questionnaires (3).
- (c) Districts (3).
- (d) Age of subject (4).
- (e) Sex of subject (2).

In addition the following were investigated for the L.S.E. students only:

- (f) Age of interviewer (2).
- (g) Sex of interviewer (2).

Operational difficulties prevented a similar split for the interviewers of the other two organizations. Table 1 shows that a sex split would in any case have been impossible for the Social Survey interviewers.

The number in brackets after each factor is the number of levels of that factor. Thus there were three sets of interviewers, three questionnaires, four age-groups of subject, etc. For economy of notation each of the first five factors will be referred to by its initial letter.

The age-groups for subject were: under 30 years, 30–39 years, 40–49 years, 50 years and over. The age-groups for L.S.E. interviewers were: Under 20 years, 20 years and over.

The total number of different combinations of the first five factors is thus $3 \times 3 \times 3 \times 4 \times 2 = 216$. Each combination was replicated seven times, giving a total of 1,512 in the sample, 504 per organization. For the L.S.E. group of 504 it was not possible to balance all the seven factors at all levels; the number of different combinations required would have been $3 \times 3 \times 4 \times 2 \times 2 \times 2 = 288$, which is not a factor of 1,512. The difficulty was met, for the analysis of this group by age and sex of interviewer, by condensing the fourfold classification by age of subject into a twofold classification.

(c) *Allocation to sample.*—The next step was to allocate the various combinations of factors (7×216) to the individuals in the sample. This was found to be much less difficult than might be imagined. It has already been remarked that the samples selected separately in the three boroughs were rather larger than the exact size required, with no attempt in the first instance at division into age and sex groups. Age and sex were, however, recorded for each individual in the sample. The sample lists were then gone through and a symbol denoting sex and age was attached to each name. The number of individuals in each group was counted, and the surplus over the exact requirements rejected by throwing out every k^{th} . This gave the right constitution according to district and age and sex of subject. Ignoring for the moment factors (f) and (g) we

* The factorial technique is due largely to R. A. Fisher—see his *Designs of Experiments* (1935) Edinburgh: Oliver & Boyd. Reference may also be made to the recent book by Cochran and Cox on *Experimental Designs* (1950) New York: John Wiley & Sons.

1951]

are left with the allocation of interviewers and questionnaires, nine combinations in all. This was carried out by going through the list of individuals in each sex-age group and assigning the nine appropriate symbols one after the other. The lists of names and addresses for each of the three organizations were then sorted out for the allocation to the individual interviewers.

(d) *Allocation to interviewers.*—A certain amount of flexibility was possible in the allocation to the interviewers, since we were interested in the groups of interviewers of the three types rather than in the relative performance of particular individuals within any group. If the interviewers had been perfectly homogeneous within organizations it would have been legitimate to have restricted each interviewer to a single questionnaire and to have confined his interviews to as small an area as possible. Such an assumption is, of course, quite unrealistic, and to cut down the variation due to differences between interviewers within organizations, it would have been desirable to have spread the assignments as much as possible.

In practice a compromise was necessary. It was agreed that the student volunteers could not be expected to undertake more than about a dozen interviews each under the conditions of this survey. However, such a small number was out of the question for the experienced investigators, since their organizations could not make enough investigators available. Furthermore, it was thought unreasonable to expect an interviewer to visit more than one borough to complete his assignment; each interviewer therefore worked in only one borough.

Subject to these restrictions the interviews were spread out as much as possible. For example, each interviewer was required to handle all three questionnaires, in approximately equal numbers, and the allocation to him of age and sex groups was approximately balanced. Furthermore, no attempt was made to cluster the interviews geographically within boroughs, which meant that the burden on the interviewers in travelling was rather greater per interview than it would normally be in a routine survey.

The names and addresses of the subjects, to which were attached symbols denoting the questionnaires to be used, were listed on the record sheets ready to be issued to the interviewers. Most of the students' assignments consisted of nine interviews, but a few of the women were asked to undertake twelve. Some of the experienced investigators' assignments consisted of thirty interviews, but most of them were given twenty.

(e) *Extra volunteers.*—Among the student interviewers there was a large surplus of men beyond those required for the main design. An extra group was therefore formed, and in this group were placed all volunteers who were obviously foreign, e.g., by accent or colour, together with the remaining surplus volunteers. (An American or Dominion accent was not regarded as foreign for this purpose.) The group contained 63 men and one woman. No considerations other than colour and command of English affected the selection of the students for the main design.

The interviewers in the extra group were divided approximately between the three boroughs and were, so far as field work was concerned, treated in exactly the same way as those in the main design.

7. THE FIELD WORK

It was decided that each organization should be responsible for the supervision of the field work of its own investigators. To make the results comparable, however, the same set of printed instructions was issued to all the investigators, and, as already noted, an effort was made to keep the verbal briefing uniform.

(a) *Briefing.*—The interviewers were divided into five groups, and a briefing meeting was held for each group to give instructions on procedure and to deal with queries. The experienced investigators attended the first two meetings and were briefed by the heads of their respective organizations. The procedure at these meetings was closely followed at the remaining three meetings held for the student volunteers. The briefing was very detailed, and all meetings lasted for at least three hours.

The interviewers were instructed to contact the subjects whose names and addresses were listed on the record sheets that had been issued to them; no substitutes were to be allowed under any circumstances. In all cases except flat refusal, removal to another address, or death, interviewers were asked to make at least three calls to try and complete the questionnaire. Whether

they made more than three calls was optional. As it turned out, some investigators did make a fourth call in a few cases in which it seemed likely that an interview would then be obtained.

General instructions were given on methods of approach, the conduct of interviews and definitions, together with detailed instructions on particular questions. These were in fairly standard form, though on the full side, and need not be enlarged upon here. The timing of calls was left to the convenience and discretion of the interviewers, but it was suggested that first calls might be made at times when it seemed likely, from the subject's age and sex, that he might be at home.

(b) *Interviewing*.—The field work itself was completed in the three weeks between April 17th and May 5th, 1950, except for one or two stragglers among the student volunteers. (These stragglers were not in the main design.) No outstanding difficulties were encountered, and most of the volunteers were agreeably surprised by the friendly co-operation they encountered. Completed questionnaires were returned by the investigators to their own organizations. The tenacity of the students was very creditable, and only three of those who went into the field failed to complete their assignments. Two of these cases were due to sickness; none of them was in the main design.

8. THE CODING

For the detailed analysis of the completed questionnaire the answers to each question had to be coded into a form suitable for punching on to Hollerith cards. Six coders were specially recruited by the D.R.T., and only one of them had any previous experience in the work.

The coding scheme was worked out by Miss Harris of the Social Survey, in collaboration with representatives from the other two organizations, on the basis of a sample of the completed questionnaire. Miss Harris also assisted in the briefing of the coders before they started work.

In order to eliminate any difference between coders from the results on particular questions, each question was coded on all the questionnaires by one person only. The 500 or so of each type of questionnaire were divided into batches of 50, and after a particular question had been coded on the first batch the results were checked by a supervisor from the D.R.T. Any points of disagreement were discussed with the coder before he continued with further batches. The remaining batches were then dealt with, and after the coding had been completed the second batch was recorded. The reason for this was that the coder's performance might have been changed with increasing experience, and it might therefore have been necessary to revise the earlier codings. In fact, there was in no case an appreciable number of discrepancies in the batches recorded. Consequently no further revision was called for. With this procedure any bias on the coder's part affects all questionnaires equally and does not, therefore, influence any comparisons of interest on particular questions, such as, for instance, the differences between the results obtained by the three sets of interviewers.

9. THE MAIN RESULTS

This section presents the main results of the inquiry in regard to the success of interviewers in making contacts, the nature of and reasons for failure, and the number of calls necessary. It is thus based very largely on information in the record sheet concerning general performance.

(a) *Success, refusal and failure to contact*.—The overall result of the inquiry for each member of the sample was classified under six heads:

1. Success. (Includes all cases in which the questionnaire was wholly or partially completed, regardless of the number of calls made.)
2. Refusal. (Includes cases in which the subject was contacted but declined to co-operate.)
3. Non-contact. (Includes cases of failure to contact the subject after at least three calls when he was known or presumed to be living at the address concerned.)
4. Gone away or deceased. (Includes cases in which the subject was not living at the address concerned, permanently or temporarily, and his new address was either not available or too far away for a further call.)
5. Unsuitable for interview. (Includes cases in which the subject was deaf, dumb, mentally defective or too ill to be interviewed.)
6. Address untraceable. (Includes cases where the investigator found it impossible to trace the address given on his assignment, for whatever reason.)

1951]

Comparisons have been made of the numbers of cases in each of these categories according to the five factors of the main experiment, namely:

- (a) Interviewers.
- (b) Questionnaires.
- (c) Districts.
- (d) Age of subject.
- (e) Sex of subject.

The results are given in Table 3. Note that the comparisons in this table are made horizontally. Thus to compare the success rates achieved by the three sets of interviewers, the relevant figures are 69.6 per cent. for the L.S.E., 83.7 per cent. for the S.S., and 81.3 per cent. for the B.I.P.O. As indicated in the table, this comparison is significant at the 1 per cent. level. This means that the differences between the three percentages taken as a group are significant, not necessarily that the difference between any particular pair of values is significant. In this particular case the significance arises from the lower rate achieved by the L.S.E. interviewers. As we shall see, there is in fact no significant difference between the percentages for the S.S. and B.I.P.O. interviewers.

TABLE 3.—Final Results of Interviews

The entries are percentages; the number of cases on which each percentage is based is given in brackets at the head of the column.

	Interviewers (504)			Questionnaire (504)		
	L.S.E.	S.S.	B.I.P.O.	Tuber- culosis	Reading	Savings
	69.6*	83.7*	81.3*	85.3*	74.4*	75.0*
Success	69.6*	83.7*	81.3*	85.3*	74.4*	75.0*
Refusal	13.5*	3.8*	3.2*	4.0*	8.5*	7.9*
Non-contact	5.8	5.0	6.7	3.6†	7.1†	6.7†
Gone away	10.1*	5.4*	7.5*	5.8	8.5	8.7
Unsuitable for inter- view	1.0	1.6	1.0	1.4	1.0	1.2
Address untraceable	—	.6	.2	—	.4	.4

	District (504)			Age of Subject (378)				Sex of Subject (756)	
	Bermond- sey	Tot- tenham	Wands- worth	—29	30-39	40-49	50—	M.	F.
	82.3*	79.8*	72.6*	77.8	79.4	77.5	78.3	77.5	79.0
Success	82.3*	79.8*	72.6*	77.8	79.4	77.5	78.3	77.5	79.0
Refusal	5.8	7.9	6.7	4.5*	4.5*	9.3*	9.0*	5.2†	8.5†
Non-contact	5.0	4.8	7.7	6.6	5.8	5.8	5.0	6.2	5.4
Gone away	6.3*	5.2*	11.5*	9.8	8.5	6.6	5.8	9.4*	6.0*
Unsuitable for interview	.6	2.2	.8	.8	1.6	.8	1.6	1.3	1.1
Address untrace- able	—	.2	.6	.5	.3	—	.3	.4	.1

Note.—Entries marked * and † indicate comparisons that are significant at the 1 and 5 per cent. levels respectively.

To assess the significance of these results we make an analysis of variance of the main design. There are seven individuals in each of the 216 combinations or "basic cells". For any given category of the six performance-classes a basic cell can thus contain 0 or 1 or . . . or 7 individuals. This number is taken as the variate and an analysis performed for the category under consideration. (In actual fact only four of the six analyses were carried out, the total number in the other two being very small.) To justify the usual tests of significance it is as well to "stabilize the variance"

by a variate transformation on the cell numbers. If x is the number in the cell we transform to a new variate y by the equation

$$y = \arcsin \sqrt{\frac{x}{7}}$$

(For a discussion of the arc sin transformation in the analysis of variance of binomial observations, see M. G. Kendall, *Advanced Theory of Statistics*, Griffin & Co., Ltd., London, vol. 2 (1948), pp. 206-9.)

Analyses were carried out for the four categories "successes", "refusals", "non-contacts" and "gone-aways". In each case contributions to the variance were worked out for all the main effects, all the first-order interactions, and all the second-order interactions in which interviewers were involved. The remaining second-order interactions and all the third and fourth-order interactions were consolidated and treated as residual error. In the resulting analyses not one of the second-order interactions was found to be significant at the 5 per cent. level; in fact, in only one case out of 24 was the variance greater than twice the error variance. Consequently these interactions also were consolidated into the error term; this, however, had a negligible effect on the error variances. The final analyses are given in Tables 4, 5, 6 and 7.

The most striking feature of the results is the insignificance of the first-order interactions. Out of 40 of them only three are declared significant by the simple test, and two of these are for the "non-contact" case, where one would not expect the interactions to be important. With 40 independent values of F the expected number appearing significant is two. The 40 values here are not of course independent, but even so it seems safe to infer that the three high values of F can be regarded as random events, and that none of the interactions is, in fact, significant.

A further test is given by consolidating the first order interactions and testing them as a whole against the residual term. When this is done it is found that the interactions for the "successes" are just significant at the 5 per cent. level, but that none of the remaining sets of interactions is significant. Once again it seems safe to conclude, subject to further information, that the interactions as a whole are not significant, since it is only the largest value of F out of four that gives apparent significance. Consequently we need not continue the analysis of interactions further.

TABLE 4.—*Analysis of Variance of Successes*

Source	Sum of Squares	D.F.	Mean Square	F
<i>Main effects—</i>				
Interviewers	1.741	2	.871	16.37†
Questionnaires	1.253	2	.627	11.79†
Districts	1.031	2	.516	9.70†
Ages	.011	3	.004	.07
Sexes	.057	1	.057	1.07
<i>Interactions—</i>				
IQ	.249	4	.062	1.17
ID	.484	4	.121	2.27
IA	.494	6	.082	1.55
IS	.003	2	.001	.03
QD	.291	4	.073	1.37
QA	.781	6	.130	2.44*
QS	.164	2	.082	1.54
DA	.532	6	.089	1.67
DS	.007	2	.004	.07
AS	.105	3	.035	.66
Residual	8.834	166	.0532	—
Total	16.037	215		

* denotes significance at the 5 per cent. level.

† " " " .1 " "

1951]

TABLE 5.—Analysis of Variance of Refusals

Source	Sum of Squares	D.F.	Mean Square	F
<i>Main effects—</i>				
Interviewers	1.7111	2	.8556	20.56†
Questionnaires	.3403	2	.1702	4.09*
Districts	.0410	2	.0205	.49
Ages	.4161	3	.1387	3.33*
Sexes	.2264	1	.2264	5.44*
<i>Interactions—</i>				
IQ	.2170	4	.0543	1.31
ID	.0169	4	.0042	.10
IA	.2002	6	.0333	.80
IS	.0689	2	.0345	.83
QD	.1895	4	.0474	1.14
QA	.2208	6	.0368	.88
QS	.1156	2	.0578	1.39
DA	.1924	6	.0321	.77
DS	.1424	2	.0712	1.71
AS	.1402	3	.0467	1.12
Residual	6.9064	166	.0416	—
Total	11.2052	215	—	—

* denotes significance at the 5 per cent. level.

† „ „ „ .1 „

TABLE 6.—Analysis of Variance of Non-contacts

Source	Sum of Squares	D.F.	Mean Square	F
<i>Main effects</i>				
Interviewers	.0673	2	.0337	.86
Questionnaires	.2613	2	.1307	3.34*
Districts	.1540	2	.0770	1.97
Ages	.0585	3	.0195	.50
Sexes	.0198	1	.0198	.51
<i>Interactions</i>				
IQ	.0339	4	.0085	.22
ID	.6707	4	.1677	4.29*
IA	.1739	6	.0290	.74
IS	.0262	2	.0131	.33
QD	.1474	4	.0369	.94
QA	.5523	6	.0921	2.30*
QS	.0106	2	.0053	.14
DA	.3860	6	.0643	1.64
DS	.0289	2	.0145	.37
AS	.0327	3	.0109	.28
Residual	6.4947	166	.0391	—
Total	9.1182	215	—	—

* denotes significance at the 5 per cent. level.

TABLE 7.—*Analysis of Variance of "Gone aways"*

Source	Sum of Squares	D.F.	Mean Square	F
<i>Main effects—</i>				
Interviewers	·4461	2	·2231	5·30**
Questionnaires	·2323	2	·1162	2·76
Districts	·8237	2	·4119	9·79†
Ages	·2605	3	·0868	2·06
Sexes	·4365	1	·4365	10·37**
<i>Interactions—</i>				
IQ	·0174	4	·0044	·10
ID	·0766	4	·0192	·46
IA	·1987	6	·0331	·79
IS	·0267	2	·0134	·32
QD	·0658	4	·0165	·39
QA	·1306	6	·0218	·52
QS	·2560	2	·1280	3·04
DA	·3691	6	·0615	1·46
DS	·0457	2	·0229	·54
AS	·1786	3	·0595	1·41
Residual	6·9816	166	·0421	—
Total	10·5459	215		

** denotes significance at the 1 per cent. level

† „ „ „ „ „

In non-technical language, what this means is that in each of the four categories analysed the performance may be regarded as the sum of *independent* effects due to district, age of subject, type of interviewer, etc. For example, if there is any influence due to age of subject it affects all three types of interviewer alike; at least, so far as this analysis shows. This itself is an interesting and valuable conclusion. It means that we can isolate our causal factors for separate consideration and, if necessary, remedial measures.

Turning now to the main effects we consider first the successes (Tables 3 and 4). The differences between interviewers, between questionnaires, and between districts are evidently highly significant. The amateurs are appreciably less successful than the experts. The easier questionnaire is more successful than the difficult. The lower class boroughs are more responsive than the middle class. The differences between the age and sex groups are not significant. The latter fact is rather encouraging as well as being something of a surprise; it is most satisfactory to discover that age and sex of subject have no significant effect upon success rate in surveys of this type. If this proves to be generally true, it removes a constant doubt in the mind of the public opinion surveyors. In the refusals (Tables 3 and 5) the only highly significant difference is between interviewers, due of course to the much higher refusal rate among the students than among the experienced investigators. Owing to the importance of the refusal factor, the figures are broken down further by organization in Table 8 below. Differences between questionnaires and between age and sex groups are moderately significant. The questionnaire effect may be due to the introductory remarks of the interviewers concerning the content of the questionnaires.

In the analysis of the non-contacts (Tables 3 and 6) the only main effect showing statistical significance is the difference between questionnaires. It is difficult to know how to interpret this effect. The actual differences are not large. When so many effects are being tested simultaneously a number of them are almost bound to show apparent significance due to sampling fluctuations, even though there might be no real difference in the underlying populations. On the other hand, it is possible that in trying to make contact with the subject the investigator in some cases revealed to other members of the household the subject-matter of the questionnaire, with the result that in subsequent calls the subject found it more congenial to be at home to be interviewed upon health

1951]

than upon reading or savings. We mention this possibility for the sake of completeness, not because we think it very plausible ourselves. The question could only be settled properly by further investigation.

The "gone aways" (Tables 3 and 7) show highly significant differences between districts and between sexes, and a lesser significance in the difference between interviewers. The two first effects are very much in accordance with expectations; the last, however, is more interesting. As for the refusals, it is the students who have the highest rate for this factor. In order to study the effect further, the relevant figures are analysed separately for the three organizations in Table 8. It should be mentioned here that the "gone away" class includes all subjects living elsewhere, whether permanently or temporarily. Owing to the manner of recording the data it is not possible to distinguish people who had made a permanent change of address from those on holiday or away on business, etc.

In the above tables the various comparisons have been tested in groups, usually with two or more degrees of freedom. Of the more detailed comparisons the only one that is of special interest is the comparison between the two professional organizations. This comparison was tested for successes, refusals, non-contacts and "gone aways"; in no case was there any significant difference between the two organizations.

The analyses of variance round off the examination of the results of Table 3. The next step in the analysis would normally be to break down the data further and study the sources of variation in greater detail. However, the value of such breakdowns is precisely what is tested by the interactions between the factors, and the analyses of variance have shown the interactions to be insignificant. Consequently we need not devote much attention to the detailed breakdown of the data in Table 3. Almost all the relevant information contained in the observations is given by the comparison in those tables. There are, however, two cases in which breakdown would seem to be of special interest. These have been mentioned above, namely, the breakdown by organization of the figures for refusals and "gone aways". The results are given in Table 8.

TABLE 8.—*Breakdown by Organization of Refusals and "Gone aways"*

The entries are percentages; the number of observations on which each percentage is based is given in brackets at the head of the column.

		Questionnaire (168)			District (168)		
		Tuber- culosis	Reading	Savings	Ber- mondsey	Totten- ham	Wands- worth
Refusal	L.S.E.	7.1	17.3	16.1	11.9	16.1	12.5
	S.S.	1.8	4.8	4.8	2.4	4.8	4.2
	B.I.P.O.	3.0	3.6	3.0	3.0	3.0	3.6
"Gone away"	L.S.E.	8.3	10.7	13.1	8.9	8.3	13.1
	S.S.	3.6	6.0	6.6	2.4	3.0	10.7
	B.I.P.O.	5.4	8.9	8.3	7.7	4.2	10.7
		Age of Subject (126)				Sex of Subject (252)	
		-29	30-39	40-49	50-	M.	F.
Refusal	L.S.E.	11.1	7.1	19.8	15.9	10.3	16.7
	S.S.	.8	4.0	4.0	6.3	2.4	5.2
	B.I.P.O.	1.6	2.4	4.0	4.8	2.8	3.6
"Gone away"	L.S.E.	13.5	7.9	11.1	7.9	12.3	7.9
	S.S.	6.3	8.7	2.4	4.0	7.1	3.6
	B.I.P.O.	9.5	8.7	6.3	5.5	8.7	6.3

There is little information in this table that we do not possess already. The results obtained by the L.S.E. students follow the general pattern set by the other two organizations, as they must, since the interactions are insignificant. Thus there are fewer refusals on the tuberculosis than on the other two questionnaires, and there is little difference between districts; there are more refusals among the older subjects than the young, and more from women than men. For "gone aways" also there is a smaller number on the tuberculosis than on the other two questionnaires for all three organizations, though the difference has been shown by the analysis of variance to be not statistically significant. There is a consistently higher number for Wandsworth than for the other two boroughs; there are more among young people than old, and more among men than women. All these results are very much what would be expected. We conclude that the tendency for the students to give higher refusal and "gone away" rates is a quality of the student-class rather than a specific reaction produced by one particular set of circumstances.

We have still to examine whether this tendency is produced by a few bad interviewers in the class, or whether, alternatively, the class may be regarded as a homogeneous group. The object so far has been to compare *types* of interviewer, and it has been supposed that the group of interviewers was homogeneous within organizations. The data can be used to test this hypothesis. The appropriate test has been given by Fisher*; it is an approximate test, but it should be adequate for present purposes. It consists merely of a comparison of the observed variance between interviewers of a particular organization with a hypothetical variance calculated on the assumption of homogeneity. We shall apply it to the success rates achieved by the three classes of interviewer.

There is a slight difference in the present application from the usual test procedure because the allocation of interviews to each individual was balanced according to questionnaire and age and sex of subject. Consequently the contribution to the variance from these sources needs to be eliminated from the estimate of the theoretical variance.

The test was applied to sets of interviewers from each organization who had equal numbers of interviews. The resulting values of χ^2 were as follows:

Organization	χ^2	Degrees of Freedom	5 per cent. Value of χ^2
L.S.E.	39.8	36	50.7
S.S.	19.4	14	23.7
B.I.P.O.	26.4	18	28.9
Total	85.6	68	87.9

None of the observed values of χ^2 is significant. We infer that the different success rates achieved by the different interviewers within organizations could have arisen by chance. That is to say, the results of this survey do not give any grounds for supposing that within the same organization there are any significant differences between interviewers' ability to achieve success. This is not the same thing as saying that no such differences exist. But the fact that they do not establish significance in an inquiry of this size suggests that they are a good deal smaller in relation to the variability of the subject's co-operation than might have been expected.

For the extra volunteer interviewers not included in the main design the position is slightly different. Here, with 59 degrees of freedom, the observed value of χ^2 is 90.5; the appropriate value at the 1 per cent. level is 86.4. Thus there is distinct evidence of differences in performance between the interviewers of this class. This effect may be due to the inclusion of coloured and foreign students in this group; the question requires further examination.

It appears then that the students, as a class, were less successful than the other organizations in obtaining completed questionnaires; that this was a feature of the class rather than of individuals; and that the disability resides in the class without being evoked particularly strongly by particular circumstances. It is natural to pursue the topic and to inquire (a) what this disability is, (b) whether it can be removed wholly or partly by a short course of instruction, and (c) whether, even where it exists in full, the amount of bias introduced is appreciable or serious. The present inquiry throws only indirect light on the first two questions; it is obvious that the differences between amateur and professional interviewers may be due to nothing more than lack of experience

* *Statistical Methods for Research Workers*, Oliver & Boyd, Edinburgh, § 19.

1951]

(and not, for instance, due to any particular innate gifts for interviewing work on the part of the professional). It is proposed to study this subject further. As regards the seriousness of the bias, everything depends on whether the failures are unrepresentative. From the foregoing analysis it does not appear that sex and age of subject are linked with failure, so that any inquiry on a topic which was highly correlated with sex or age might not be biased. The question whether it is safe to use inexperienced investigators must be considered afresh for each inquiry in which it is proposed to use them. What the present investigation does is to show that the possibility of bias exists and give some indication of its extent. Further studies of this subject will be undertaken by the Division.

(b) *Age and sex of student interviewers.*—In the analyses made so far the student interviewers have been implicitly regarded as a homogeneous group, although, as pointed out in section 6 (b), the design was balanced for these interviewers according to their age and sex. The comparisons of the results obtained by the different age and sex groups are given in Table 9. The results obtained by the 64 extra volunteers not in the main design are given in the last column of the table; they have not been classified by age of interviewer since there were only ten interviewers in the nineteen-and-under age group.

TABLE 9.—*Classification by Age and Sex of the Results Obtained by L.S.E. Interviews*

	L.S.E. Interviewers in Main Design				L.S.E. Interviewers not in Main Design
	Age (252)		Sex (252)		Design (560)
	-19	20-	M.	F.	
Success	74.2*	65.1*	68.7	70.6	68.4
Refusal	11.5	15.5	13.5	13.5	13.6
Non-contact	5.2	6.3	5.6	6.0	7.7
Gone away	8.3	11.9	11.5	8.7	8.2
Unsuitable for interview	.8	1.2	.8	1.2	1.1
Address untraceable	—	—	—	—	1.1

Note.—The comparison marked * is significant at the 5 per cent. level.

The differences between the results obtained by the two age groups are much larger than the differences due to sex; yet the age differences themselves are small, as Table 10 below shows. Moreover, the apparent superiority of the younger over the older interviewers runs counter to what one might have expected. Further light will be thrown on this question below.

TABLE 10.—*Age and Sex Distribution of L.S.E. Interviewers in the Main Design*

	18, 19	20, 21	22, 23	24, 25	26–	Total
M.	14	6	6	2	3	31
F.	11	7	3	2	1	24

Strictly speaking the variation due to age and sex of the student interviewers should have been allowed for in the analyses of variance in Tables 4–7. However, the effect on the conclusions drawn so far would have been very small, and it seems preferable to consider separately the significance of the effects due to age and sex of interviewers. The appropriate analyses of variance, somewhat abbreviated, are given in Tables 11–14. Only those interactions that are statistically significant have been included.

TABLE 11.—*Analysis of Variance of Successes for L.S.E. Interviewers*

Source	D.F.	Mean Square	F
Age of interviewer	1	.2563	5.109*
Sex of interviewer	1	.06266	1.249
Age-sex interaction	1	.3534	7.04*
Residual	56	.05018	—

* denotes significance at the 5 per cent. level.

TABLE 12.—*Analysis of Variance of Refusals for L.S.E. Interviewers*

Source	D.F.	Mean Square	F
Age of interviewer	1	·1811	2·777
Sex of interviewer	1	·00671	·103
Residual	56	·06522	—

TABLE 13.—*Analysis of Variance of Non-contacts for L.S.E. Interviewers*

Source	D.F.	Mean Square	F
Age of interview	1	·01256	·3383
Sex of interviewer	1	·00502	·1351
Age-sex interaction	1	·4366	11·76*
Residual	56	·03713	—

TABLE 14.—*Analysis of Variance of Gone-aways for L.S.E. Interviewers*

Source	D.F.	Mean Square	F
Age of interviewer	1	·06325	1·063
Sex of interviewer	1	·1442	2·424
Residual	56	·05948	—

* denotes significance at the 1 per cent. level.

It is rather remarkable that there are no significant interactions between age and sex of interviewer and age and sex of subject. In fact, the only effects showing significance are age of interviewer for the success rate, and the age-sex of interviewer interaction for successes and non-contacts. The relevant subtabulations are:

	Successes			Non-contacts	
	Young	Old		Young	Old
Male	86	87	Male	10	4
Female	101	77	Female	3	12

The figures given are numbers of cases out of the 252 interviews assigned.

It follows from these subtabulations that the interaction effect in the successes is due mainly to the interaction in the non-contacts. Though the latter effect is statistically significant it seems reasonable to attach only a limited importance to it, partly because of the small differences in age between the two groups and partly because of the small number of cases involved.

(c) *Number of calls.*—A knowledge of the number of calls necessary on the average to obtain an interview and the expectation of success at each of the successive calls is of great value for the planning of surveys. A detailed analysis has therefore been made of the results achieved at each call.

The percentages of the total successes that were obtained at the successive calls by the interviewers from the three organizations are shown in Table 15.

TABLE 15.—*Percentage of Successes Obtained at the Successive Calls*

Organization	Call 1	Call 2	Call 3	Call 4	Total Successes
L.S.E. (main design)	51·3	38·2	8·8	1·7	351
S.S.	31·5	47·4	18·5	2·6	422
B.I.P.O	45·9	36·3	15·4	2·4	410
L.S.E. (extra)	54·3	38·1	7·0	0·5	383

Thus of the 351 successes obtained by the L.S.E. interviewers, 51·3 per cent. were obtained at the first call, 38·2 per cent. at the second call, and so on.

1951]

TABLE 16.—Percentage Success of Outstanding Cases

	Call 1	Call 2	Call 3
L.S.E. (main design)	35.7 (504)	55.0 (244)	46.2 (67)
S.S.	26.4 (504)	58.1 (344)	62.9 (124)
B.I.P.O.	37.3 (504)	53.0 (283)	54.3 (116)
L.S.E. (extra)	37.1 (560)	56.2 (260)	37.5 (72)

The number of outstanding cases on which each percentage is based is given in brackets. This is the number of cases for which interviews were being sought at the call concerned. The total number of calls made and the mean number of calls per success are given in Table 17.

TABLE 17.—Number of Calls per Success

	Calls	Successes	Mean Number of Calls per Success
L.S.E.	823	351	2.34
S.S.	988	422	2.34
B.I.P.O.	933	410	2.28
L.S.E. (extra)	890	383	2.32

In Table 18 the calls per success are analysed by sex and age of subject.

TABLE 18.—Number of Calls per Success by Sex and Age Group

Sex	Age-Group	Calls	Successes	Calls per Success
M.	-29	355	151	2.35
M.	30-39	350	150	2.33
M.	40-49	357	142	2.51
M.	50-	327	143	2.29
F.	-29	354	143	2.48
F.	30-39	344	150	2.30
F.	40-49	339	151	2.24
F.	50-	318	153	2.08
Total males		1,389	586	2.37
Total females		1,355	597	2.27

The most striking feature of Tables 15 and 16 is the low success rate of the Social Survey investigators at the first call, followed by high success rates at the second and third calls. This difference appears to be due mainly to the greater proportion of daytime calls made by the Social Survey investigators; the point will be taken up in section 9 (d). Taking the results as a whole, the chance of one in three of getting an interview at the first call agrees exactly with the figure given by Gray and Corlett; their other figure of 60 per cent. success at the second call is, however, about 5% higher than the average attained in this survey.

There is very little difference in mean number of calls per success between the three organizations, and the difference between male and female subjects is smaller than might have been expected. When analysed by age groups the figures for men do not reveal any particular pattern, but for women the mean diminishes steadily with increasing age. Here again the differences are rather smaller than might have been expected.

In Table 19 an analysis of successes obtained at the second call is made according as an appointment was or was not made at the first call. Clearly there was a very good chance of obtaining an interview when an appointment had been made; it was in fact nearly twice as great as when an appointment had not been made. However, the gain was substantially less for women than for men. It is interesting to note that the chance of obtaining an interview at the second call without an appointment was greater, though not much greater, than the chance of obtaining an interview at the first call.

The table shows clearly that the Social Survey investigators' advantage at the second call did not arise from the greater number of appointments they made—in fact, the students made almost

as many—but from their success in obtaining interviews whether an appointment had been made or not.

TABLE 19.—*Successes at the Second Call*

The figures given are percentages. The number of calls on which each percentage is based is given in brackets at the side.

	Males		Females		All	
	Appoint- ment Made at First Call	No Appoint- ment Made at First Call	Appoint- ment Made	No Appoint- ment Made	Appoint- ment Made	No Appoint- ment Made
L.S.E. (main design)	69.7 (76)	34.1 (44)	58.0 (81)	44.2 (43)	63.7 (157)	39.1 (87)
S.S.	73.4 (102)	34.2 (76)	80.7 (57)	50.0 (96)	79.2 (159)	43.0 (172)
B.I.P.O.	67.5 (80)	35.3 (68)	72.6 (62)	37.0 (73)	69.7 (142)	36.2 (141)
All	72.5 (258)	34.6 (188)	69.0 (200)	44.3 (212)	71.0 (458)	39.8 (400)

(d) *Times of calls.*—A good deal of valuable information on the effect on the success rate of the time of call was collected in the survey. The interviewers were asked to indicate on the record sheet in which of the following time intervals the call was made: Before noon, noon–2 p.m., 2–5 p.m., 5–7 p.m., after 7 p.m. Only the times of first calls have been analysed in detail since the subsequent calls were often arranged at times convenient to the subject. It is obvious that the effect of time of call is quite different at the weekends from weekday calls; the Saturday and Sunday calls have therefore been treated separately.

TABLE 20.—*Percentages of Successes at Different Times of Day Classified by Interviewers.*
Weekday Calls only

The number of calls on which each percentage is based is given in brackets.

Interviewers	Time of Day	Male Subjects	Female Subjects	Both Sexes
Social Survey	Before noon	11 (54)	22 (60)	17 (114)
	Noon–2 p.m.	20 (35)	29 (45)	25 (80)
	2–5 p.m.	12 (89)	34 (119)	25 (208)
	5–7 p.m.	45 (40)	47 (19)	46 (59)
	After 7 p.m.	71 (14)	67 (3)	71 (17)
B.I.P.O.	Before noon	8 (24)	49 (39)	33 (63)
	Noon–2 p.m.	20 (25)	33 (21)	26 (46)
	2–5 p.m.	25 (44)	34 (77)	31 (121)
	5–7 p.m.	30 (47)	43 (42)	36 (89)
	After 7 p.m.	52 (50)	61 (23)	55 (73)
L.S.E. (main design)	Before noon	25 (4)	39 (23)	37 (27)
	Noon–2 p.m.	10 (10)	15 (13)	13 (23)
	2–5 p.m.	14 (42)	31 (91)	26 (133)
	5–7 p.m.	38 (74)	27 (48)	34 (122)
	After 7 p.m.	45 (86)	45 (38)	45 (124)
L.S.E. (extra volunteers)	Before noon	12 (8)	36 (11)	26 (19)
	Noon–2 p.m.	38 (8)	33 (12)	35 (20)
	2–5 p.m.	17 (42)	27 (105)	24 (147)
	5–7 p.m.	40 (62)	47 (38)	43 (100)
	After 7 p.m.	45 (86)	43 (51)	44 (137)
All	Before noon	11 (90)	34 (133)	25 (223)
	Noon–2 p.m.	20 (78)	29 (91)	25 (169)
	2–5 p.m.	16 (217)	31 (392)	26 (609)
	5–7 p.m.	38 (223)	40 (147)	39 (370)
	After 7 p.m.	48 (236)	48 (115)	48 (351)

1951]

TABLE 21.—Percentage of Successes at Different Times of Day Classified by Subjects.
Weekday Calls only

The number of calls on which each percentage is based is given in brackets.

		Age of Subject			
Time of Day		—30	30–39	40–49	50–
Male subjects	Before noon	6 (17)	12 (24)	4 (22)	18 (27)
	Noon–2 p.m.	17 (23)	7 (15)	19 (26)	43 (14)
	2–5 p.m.	16 (50)	7 (45)	13 (45)	23 (77)
	5–7 p.m.	33 (58)	43 (49)	21 (47)	51 (69)
	After 7 p.m.	50 (62)	41 (58)	48 (52)	53 (64)
Female subjects	Before noon	19 (32)	44 (32)	24 (34)	49 (35)
	Noon–2 p.m.	18 (28)	33 (18)	31 (16)	34 (29)
	2–5 p.m.	21 (76)	33 (98)	32 (94)	36 (124)
	5–7 p.m.	38 (42)	36 (33)	25 (32)	55 (40)
	After 7 p.m.	43 (47)	53 (17)	67 (18)	42 (33)

TABLE 22.—Percentages of Successes on Week-end Calls

The number of calls on which each percentage is based is given in brackets.

Interviewers	Male Subjects	Female Subjects	Both Sexes
Social survey	15 (20)	0 (6)	12 (26)
B.I.P.O.	50 (52)	42 (50)	46 (102)
L.S.E.	50 (36)	51 (39)	51 (75)

The first point of interest shown by these tables is the difference in the times of calls made by the interviewers of the three organizations. By far the majority of the Social Survey investigators' calls were made in the morning and afternoon of the ordinary weekdays. The remaining interviewers tended to a much greater extent to make their first attempts in the evenings and at week-ends. Since there is much less chance of obtaining a successful interview in the daytime, this is an important reason why the success rate of the Social Survey investigators at the first call was rather less than the rates achieved by the other organizations (cf. Tables 15 and 16).

The success rates at the different times follow the expected pattern. Men are more elusive than women in the daytime, and both sexes are easier to interview in the evenings. The chance of a daytime interview with women under 30 or men under 50 is about one in five or less; the chance for women over 30 is about one in three. There is very little variation due to age and sex in the chance of an evening call, the chance being about 40–50 per cent., roughly the same as for a week-end call.

10. SUMMARY AND CONCLUSIONS

This inquiry was designed to investigate differences in performance between experienced and inexperienced interviewers. Since this paper deals only with response rates we cannot claim to have taken more than the first step in the analysis.

So far as success in obtaining interviews is concerned the students were decidedly, though not overwhelmingly, inferior to the interviewers of the two professional organizations. There appears to be very little difference in performance between the male and female students, and though the younger students' results are significantly superior to the elder students according to the statistical test, the age differences are so small that this may not indicate a real difference of any importance.

The response rate of each group of interviewers was remarkably constant over variations in the remaining factors, and within each group there is no evidence of marked heterogeneity among the individual interviewers. These results show that the main differences are between classes of interviewers rather than between individuals, and that these differences are very little affected by the circumstances of the interviews, at least under the conditions of this survey.

One of the most interesting features of the results is the insignificance of the interaction terms. It is particularly noteworthy that age seems to have no effect on the differences in response between the two sexes, and that the interactions between age and sex of the student interviewers and age

and sex of subject are of negligible size. The importance of these results is that in future inquiries of the same kind we shall be able to concentrate our attention on the main factors of interest without having to worry too much about the effects of different combinations of factors.

There were no marked divergencies from expectation in the analyses of numbers of calls and times of calls, but the information obtained should nevertheless prove to be of very great value for the design of future surveys.

In planning the inquiry great emphasis was laid on the need for proper statistical design, and we hope that our experience will encourage other workers in the field to adopt similar methods. Although highly elaborate designs are often used in other sciences, it is not unnatural that in a field in which the experimental material is composed of human beings, the tendency should have been towards simplicity of layout. In our own experience, however, the extra amount of organization necessitated by the design we used proved to be a good deal less troublesome than had been expected.

Though the inquiry has demonstrated the inferiority of the students in obtaining interviews when compared with professional interviewers, it tells us nothing of the causes of the differences and whether they can easily be remedied. Is it simply a matter of inexperience, or are the differences due in part at least to deeper causes, such as the students' youthfulness or the personality characteristics of people who go to universities? To investigate these matters further inquiries are needed, in which, for instance, some of the students would be given a short course of training before starting on the field work proper. It is hoped to include projects along these lines in the future research programme of the Division.

1951]

APPENDIX A

SURVEY RESEARCH UNIT

TUBERCULOSIS

1 What disease would you say kills most people in this country ?

2 What disease would you say you think most about ?

3 Which next ?

4 What would you say is the main cause of pulmonary (chest) T.B. ?

If not mentioned in answer to Q. 4.

5 (a) Do you think that bad housing conditions can cause T.B. ? Yes1
No2
Don't know.....3

(b) Do you think that poor food and not enough food can cause T.B. ? Yes1
No2
Don't know.....3

(c) Do you think that not having enough rest can cause T.B. ? Yes1
No2
Don't know.....3

6 Can you say what the symptoms of (pulmonary) T.B. are ?

7 Do you think that it is hereditary ? Yes1
No2
Don't know.....3

8 (a) If NO (2) or Don't know (3) to Question 7: Do you think that it runs in families in any way ? Yes1
No2
Don't know.....3

(b) If YES (1) to Question 8(a): In what way ?

9 What is the best way of treating T.B. ?

10 (a) Do you think that it is preventable ? Yes1
No2
Don't know.....3

(b) Do you think it is curable ? Yes, completely 1
Yes, partly2
No3
Don't know.....4

Yes, if

11 Do you think that it is catching (infectious, contagious) ? Yes1
No2
Don't know.....3

12 (a) Which do you think are more liable to T.B., men or women ? Men1
Women2
Both equally3
Don't know.....4

(b) Of any particular age group ?

13 Do you think that there are many people who are afraid to be examined in case they have T.B. ? Yes, many1
Yes, a few2
No3
Don't know.....4

14 (a) Do you think that it is a good idea to have everyone's chest regularly checked by X-ray ? Yes1
No2
Don't know.....3

(b) Have you ever had yours checked ? Yes1
No2

(c) If YES: About how long ago ?

(d) Would you have any idea where to go to have it checked now ? Yes, at1
No2

15 Have you any idea of what causes other forms of T.B.: e.g. in joints ?

16 (a) Have you ever heard of the BCG vaccine ? Yes1
No2

(b) If YES (1): Do you think that it is a good idea for the Government to spend money in providing it ? Yes1
No2
Don't know.....3

17 Have you any idea of what special provisions there are for people suffering from T.B. ?

18 Do you think that there are or are not sufficient hospitals and sanatoria available for T.B. patients ? Are1
Are not2
Don't know.....3

19 Do you think that T.B. is a serious problem in this country ? Yes, very.....1
Yes, but not very 2
No3
Don't know.....4

20 Which would you say is the more serious problem in this country, T.B. or Polio (infantile paralysis) ? T.B.1
Polio2
Same3
Don't know.....4

21 If the Government spent money sending T.B. patients to Switzerland would you approve or are there better things for them to spend their money on ? Approve1
Disapprove2
Don't know.....3

22 You don't have to answer, but would you mind saying whether anyone in your own family has had T.B. ? Yes, now1
Yes, did have it 2
None3

APPENDIX B

SURVEY RESEARCH UNIT

READING HABITS

1 DAILY PAPERS

- (a) If interview is on a Monday ask of preceding Saturday. Did you see a morning paper yesterday ? Which one(s) ?
- (d) Do you read any daily morning paper(s) regularly—that is on at least three days a week ? Which one(s) ?

	(a)	(d)
None	X	X
Don't remember, vague...	Y	Y
Express	1	1
Mirror	2	2
Mail	3	3
Herald	4	4
News Chronicle	5	5
Graphic (Sketch)	6	6
Telegraph	7	7
Times	8	8
Worker	9	9
Other (specify)	0	0
Other (a) (specify)		
Other (d) (specify)		

	(b)	(e)
(e) Code number of paper first mentioned		
D.N.A.	Y	Y

ASK ABOUT PAPER CODED IN (b)

- (c) Would you say you :—
- (c)
- Read most of it 1 |

Read some of it only 2 |

Just glanced at headlines 3 |

D.N.A. 4 |

ASK ABOUT PAPER CODED IN (e)

- (f) Which part of the paper do you most like looking at ?

	(f)
D.N.A.	1
News items	2
Sport	3
Comic strips	4
Letters	5
Fiction	6
Puzzles, etc.	7
Leading articles	8
Advertisements	9
Other (specify)	0

2 SUNDAY PAPERS

- (a) Did you see a Sunday paper last Sunday ? Which one(s) ?
- (d) Do you read any Sunday paper(s) regularly—that is to say, every week as a rule ? Which one(s) ?

	(a)	(d)
None	X	X
Don't remember, vague	Y	Y
News of the World	1	1
Pictorial	2	2
Express	3	3
People	4	4
Chronicle	5	5
Empire News	6	6
Reynold's	7	7
Dispatch	8	8
Graphic	9	9
Observer, Times	0	0
Other (specify)	A	A
Other (a) (specify)		
Other (d) (specify)		

	(b)	(e)
(e) Code number of paper first mentioned		
D.N.A.	Y	Y

ASK ABOUT PAPER CODED IN (b)

- (c) Would you say you :—
- (c)
- Read most of it 1 |

Read some of it only 2 |

Just glanced at headlines 3 |

D.N.A. 4 |

ASK ABOUT PAPER CODED IN (e)

- (f) Which part of the paper do you most like looking at ?

	(f)
D.N.A.	1
News items	2
Sport	3
Comic strips	4
Letters	5
Fiction	6
Puzzles, etc.	7
Leading articles	8
Advertisements	9
Other (specify)	0

3 EVENING PAPERS

- (a) If interview is on a Monday ask of preceding Saturday. Did you see an evening paper yesterday ? Which one(s) ?
- (d) Do you read any daily evening paper(s) regularly—that is on at least three nights a week ? Which one(s) ?

	(a)	(d)
None	X	X
Don't remember, vague	Y	Y
Star	1	1
News	2	2
Standard	3	3
Other (specify)	4	4
Other (a) (specify)		
Other (d) (specify)		

	(b)	(e)
(e) Code number of paper first mentioned		
D.N.A.	Y	Y

ASK ABOUT PAPER CODED IN (b)

- (c) Would you say you :—
- (c)
- Read most of it 1 |

Read some of it only 2 |

Just glanced at headlines 3 |

D.N.A. 4 |

ASK ABOUT PAPER CODED IN (e)

- (f) Which part of the paper do you most like looking at ?

	(f)
D.N.A.	1
News items	2
Sport	3
Comic strips	4
Letters	5
Fiction	6
Puzzles, etc.	7
Leading articles	8
Advertisements	9
Other (specify)	0

1951]

4 Do you read any of the local weekly newspapers regularly—that is to say practically every week ?

YesY
NoX

5 Do you read any magazines or journals or monthly or weekly papers regularly—that is to say practically every time they come out ?

Yes0
No1

(a) If YES (0): Can you tell me the names of the magazines or journals you read regularly ?
PROBE: are there any others that you read regularly ?

D.N.A.9

6 During the past 7 days, roughly how many hours would you say you had spent reading newspapers, journals and magazines ?

No time at all.....2
Less than $\frac{1}{2}$ hour.....3
 $\frac{1}{2}$ hour—2 hours4
Over 2 hours—7 hours ...5
Over 7 hours—14 hours ...6
Over 14 hours.....7
Cannot estimate.....8

IF CANNOT ESTIMATE (8), give reason

7 (a) Apart from weekends, can you tell me what times of day and in what places you do most of your reading of newspapers and magazines ?

TIME OF READING (state a.m. or p.m.)
WHERE READING DONE (be specific)

Can't sayY
Don't do anyX

From..... To.....
From..... To.....
From..... To.....

(b) And what about weekends ?

Can't sayY
Don't do anyX

From..... To.....
From..... To.....
From..... To.....

8 IF DON'T DO ANY IN 7(a) AND 7(b) DON'T ASK QUESTION BUT CODE APPROPRIATELY.

Would you say you do most of your reading of magazines and newspapers at home or in some other place ?

Don't do anyY
Don't know or doubtful...X
About half and half0
Mostly at home1
Mostly at some other place2
Other answer (specify) 3

9 Is there anything which makes it difficult for you to read magazines and newspapers while you are at home ?

No, nothing; Can't think of anything; Don't know ...9
Other answer (VERBATIM)

10 Apart from monthly and weekly magazines or papers, do you read books at all ?

Yes4
No5

If YES (4) ask Questions 11 onwards.

If NO (5), go on to Question 34.

11 Are you reading any book of any kind at the moment ?

Yes6
No7

If YES (6), ask Questions 12 onwards.

If NO (7), go on to Question 18.

12 What is the name of the book ?

Doesn't remember8
Names book (specify verbatim)9

13 Can you tell me who wrote it ?

Doesn't rememberY
Names author (specify verbatim)X

14 What is it about? VERBATIM. NO PROBE.

15 Is there anything you particularly like about it? VERBATIM. NO PROBE.

16 Is there anything you particularly dislike about it? VERBATIM. NO PROBE.

17 On the whole would you say it is a good book or not particularly good ?

Not particularly good ...1
Good2
Not read enough of it to say3
Other answer (specify) ...4
Don't know.....5

If NOT PARTICULARLY GOOD (1), ask Questions 18 onwards.

If GOOD, NOT READ ENOUGH, OTHER ANSWER, D.K. (2, 3, 4, 5), go on to Question 23.

To all who read books, but are not now reading a book, or whose present book is "NOT PARTICULARLY GOOD":

18 Can you tell me the name of the last good book you read ?

Doesn't remember6
Names book (specify verbatim)7

- 19 Can you tell me who wrote it ?
Doesn't remember8
Names author (*specify*
verbatim)9

20 What was it about ? *VERBATIM. NO PROBE.*

21 What did you particularly like about it ?
VERBATIM. NO PROBE.

22 Was there anything you didn't like about it ?
VERBATIM. NO PROBE.

TO ALL WHO READ BOOKS:

23 During the past week roughly how many hours would you say you had spent reading books—I mean books, not magazines and papers ?

No time at all.....Y
Less than $\frac{1}{2}$ hourX
 $\frac{1}{2}$ hour—2 hours0
Over 2 hours—7 hours1
Over 7 hours—14 hours2
Over 14 hours3
Cannot estimate4

IF CANNOT ESTIMATE (4), give reason.

24 (a) Apart from weekends, can you tell me what times of day and in what places you do most of your book reading ?

Time of Reading (state a.m. or p.m.)	Where Reading done (be specific)
Can't say .....Y	

From..... To.....	.....
From..... To.....	.....
From..... To.....	.....
From..... To.....	.....
From..... To.....	.....

(b) And what about weekends ?

Can't say .....Y	
From..... To.....	.....
From..... To.....	.....
From..... To.....	.....
From..... To.....	.....
From..... To.....	.....

25 How do you get most of the books you read ?
Do you buy them, borrow them from friends, get them from a library, or what ?

IF LIBRARY MENTIONED, PROBE FOR TYPE OF LIBRARY.

Buy them .....Y	
CODE Borrow from friends .....X	
ALL Public Library .....0	
THAT Subscription library .....1	
APPLY 2d. library (so much per book) .....2	
Other source (<i>specify</i>) .....3	

26 Do you like to find any of the things on this list in the books that you read ?

HAND LIST TO INFORMANT AND READ OUT ALOUD WITH INFORMANT FOLLOWING. ALLOW AMPLE TIME AND RE-READ IF REQUIRED.

Something funny .....Y	
Something to make you think or help you to learn .....X	
Something true to life .....0	
Something deep, something to get your teeth into .....1	

CODE A good long book .....2	
ALL Some action and excitement .....3	
THAT Some romance and love .....4	
APPLY Something that expresses your own thoughts and feelings .....5	
Something about "real" characters or people .....6	
Something unusual, not about everyday life or people .....7	
Or don't you particularly care for any of these things .....8	

27 Now would you tell me the number of any of the subjects on this card that particularly interest you—just the ones you are specially interested in ?

HAND LIST TO INFORMANT AND READ OUT ALOUD WITH INFORMANT FOLLOWING. ALLOW AMPLE TIME AND RE-READ IF REQUIRED.

Famous men and women of the past 01	
Famous men and women of the present .....02	
Politics and economics .....03	
Scientific and technical books to do with your job or hobbies .....04	
Scientific and technical books NOT to do with your job or hobbies .....05	
Health and hygiene .....06	

CODE Sex .....07	
ALL Psychology and how to live .....08	
THAT Problems of our society .....09	
APPLY How to get educated .....10	
Religion .....11	
Classics—famous old literature .....12	
Modern classics—famous modern literature .....13	
Music .....14	
Any other sort of artistic activity .....15	
Sport and recreation .....16	
Travel and exploring .....17	
Running a house .....18	
Or don't you particularly care for any of these things ?19	
Other interest (<i>specify</i>) .....20	

1951]

28 When you are reading novels and stories which of these specially interest you ?

HAND LIST TO INFORMANT AND READ OUT ALOUD WITH INFORMANT FOLLOWING. ALLOW AMPLE TIME AND RE-READ IF REQUIRED.

- Detective and mystery storiesY
 Adventure and western storiesX
 Love and happy ending stories0
 CODE Funny, humorous, satirical stories...1
 ALL Horror, supernatural, uncanny
 THAT stories2
 APPLY Novels about political, economic
 or social problems3
 Novels about philosophical problems 4
 Character and psychological stories
 of any sort5
 Character and psychological stories
 about families6
 Historical stories—stories set in
 different times from the present ...7
 Short stories8
 None of these9

29 Is there anything about a book that puts you off reading it once you've started it ?

30 Do you, yourself, hold a ticket for the Public Library in this Borough ?

- Yes5
 No6
 Other answer (specify)7

If YES (5), ask Questions 31 onwards.

If NO or OTHER ANSWER (6, 7), go on to Question 34.

31 How long would it normally take you to get to the Public Library ?

- Less than 10 minutesY
 10-30 minutesX
 Over 30 minutes0
 Don't know1

32 When did you last borrow a book or books from the Public Library ?

- Up to 1 week ago2
 Over 1 to 2 weeks ago3
 Over 2 to 4 weeks ago4
 Over 1 month to 3 months ago5
 Over 3 months to 6 months ago5
 Over 6 months to 1 year ago7
 Over 1 year ago8

33 (a) Do you remember the title(s) ?
 (b) Do you remember the author(s) ?
 (c) If NO to (a) or (b): Could you give me an idea of what it was (they were) about ?

33

a.	TITLE	b.	AUTHOR	c.	SUBJECT MATTER

TO ALL:

34 Now would you mind telling me at what times you were at home yesterday ? *ASK ABOUT EACH TIME IN TURN.*

(a) Were you reading at all during any of the hours you were at home ? *CHECK EACH TIME IN TURN.*

(b) Was the radio on in the room where you were ?

(c) Were any children present in the room with you ?

(d) How many adults were present in the room with you ?

} *ASK FOR EACH HOUR WHEN AT HOME.*

Time	Not at home	At home							
		CODE ONE ONLY				CODE ONE ONLY			
		a. b.	Reading Radio on off	Not reading Radio on off	c. Children present d. No. of adults 0 1 1+	d. No. of adults 0 1 1+	Children not present d. No. of adults 0 1 1+		
Up to 8 a.m.	57	1 2	3 4	1 2 3	4 5 6				
After 8—9 a.m.	57	1 2	3 4	1 2 3	4 5 6				
After 9—10 a.m.	57	1 2	3 4	1 2 3	4 5 6				
After 10—11 a.m.	57	1 2	3 4	1 2 3	4 5 6				
After 11—12 noon	57	1 2	3 4	1 2 3	4 5 6				
After 12—1 p.m.	57	1 2	3 4	1 2 3	4 5 6				
After 1—2 p.m.	57	1 2	3 4	1 2 3	4 5 6				
After 2—3 p.m.	57	1 2	3 4	1 2 3	4 5 6				
After 3—4 p.m.	57	1 2	3 4	1 2 3	4 5 6				
After 4—5 p.m.	57	1 2	3 4	1 2 3	4 5 6				
After 5—6 p.m.	57	1 2	3 4	1 2 3	4 5 6				
After 6—7 p.m.	57	1 2	3 4	1 2 3	4 5 6				
After 7—8 p.m.	57	1 2	3 4	1 2 3	4 5 6				
After 8—9 p.m.	57	1 2	3 4	1 2 3	4 5 6				
After 9—10 p.m.	57	1 2	3 4	1 2 3	4 5 6				
After 10—11 p.m.	57	1 2	3 4	1 2 3	4 5 6				
After 11—12 p.m.	57	1 2	3 4	1 2 3	4 5 6				

35 (a) What time did you get up yesterday ?..... (b) What time did you go to bed yesterday ?.....

1951]

APPENDIX C

SURVEY RESEARCH UNIT

SAVINGS

- 1 Compared with two or three years ago, would you say that most of the people you yourself know are better off, worse off, or much the same as they were ?

Better offY
Worse offX
Same as they were0
Don't know2
Other and qualified answers (specify) 1

- (a) If WORSE OFF (X): Would you say they are much worse off than they were two or three years ago or only a little worse off ?

Much worse off.....3
Little worse off.....4
Don't know6
Other and qualified answers (specify) 5

- 2 During the coming year do you think things will get better or worse for people in your position, or do you think there is not likely to be much change ?

BetterY
WorseX
Not much change0
Don't know.....2
Other and qualified answers (specify) 1

- 3 So far as wages are concerned do you think there will be much change in the coming year ?

Yes, some change3
No, no change4
Don't know.....5

- (a) If YES, SOME CHANGE (3): Do you think wages will be higher or lower ?

D.N.A.....9

- 4 During the coming year do you think prices in the shops will go up, come down, or stay about the same ?

Go upY
Some will go up—not othersX
Stay the same.....0
Some will come down—not others ...1
Come down.....2
Don't know.....4
Other answer (specify)3

- (a) If GO UP, SOME GO UP, NOT OTHERS (Y, X): Were you thinking of the prices of any particular things when you said that prices would go up ?

D.N.A.9
No8
Yes (specify)7

- (b) If COME DOWN, SOME COME DOWN, NOT OTHERS (1, 2): Were you thinking of the prices of any particular things when you said that prices would come down ?

D.N.A.7
No9
Yes (specify)8

- 5 Nowadays, when you've paid all your usual living expenses, do you have anything left over ?

Yes, something left5
No, nothing left6
Don't know.....8
Other answer (specify)7

"A lot is said these days about it being good for the Country if people save money . . ."

- 6 How do you feel about this ? (VERBATIM).

- 7 Are you yourself in a position to save anything just now ?

Yes, am in position to save2
No, am not in position to save3
Don't know.....5
Other answer (specify)4

- (a) If YES, IN POSITION TO SAVE (2): Are you actually saving at all at present ?

D.N.A.9
Yes, saving.....6
No, not saving7
Other answer (specify)8

If SAVING NOW, ask Questions 8 onwards.
If NOT SAVING NOW, go on to Question 10.

- 8 Are you saving up for anything special or just so that you will have something to fall back on in emergency ? (VERBATIM)

- 9 Have you any plan or regular way of saving or do you just put some money aside every now and then when you can afford it ?

PlanY
No planX
Other answer (specify)0

- (a) If PLAN (Y): Find out and record details of plan or regular way of saving. See instructions.

D.N.A.9

TO ALL:

- 10 Have you got any National Savings Certificates now ?

Yes1
No2

- If NO: Did you ever have any ?

Has got some nowY
Has none now but had some.....X
Never had any-

- (a) If NONE NOW BUT HAD SOME (X): Can you remember when you sold the last of them ?

D.N.A.Y
Can't rememberX
Year.....

**(b) If EVER HAD ANY CERTIFICATES
(Y, X in Question 10):**

(i) When did you first buy any ?

D.N.A. Y
 Can't remember X
 Vague answer (*specify*) O
 Year

(ii) Have you bought any for yourself since the beginning of 1949 ?

D.N.A. 1
 Yes 2
 No 3

If has some Certificates now, ask Questions 11 onwards.

If has no Certificates now, go on to Question 12.

TO THOSE WHO HAVE SOME CERTIFICATES NOW:

11 (a) Would you mind telling me how many units in National Savings Certificates you have now ?

(b) Did you buy any certificates of the 8th issue since January 1st, 1949 ? How many did you buy ?

(c) Did you sell any certificates of any issue since January 1st, 1949 ? How many did you sell ?

PROMPT EACH ISSUE.

ISSUE	(a) No. of Units held	(b) No. of Units bought since Jan. 1, 1949	(c) No. of Units sold since Jan. 1, 1949
	No. None	No. None	No. None
1st issue	0		0
2nd issue	0		0
3rd issue	0		0
Conversion	0		0
4th issue	0		0
5th issue	0		0
6th issue	0		0
7th issue	0		0
£1 issue	0		0
8th issue	0		0
Total Units			

Subject referred to certificates Y

Subject did not refer to certificates ... X

INVESTIGATOR'S COMMENTS**TO ALL:**

12 Have you an account open at the Post Office Savings Bank ? I mean any account, even one you haven't put anything into for a long time ?

Yes 4
 No 5

13 Have you got an account at any other sort of Savings Bank or a savings account at an ordinary bank excluding current and deposit accounts ?

Yes 6
 No 7

If has Savings Account anywhere ask Question 14 onwards.

If hasn't Savings Account go on to Question 19.

14 When did you last put anything into your Savings account ? **EXCLUDE CURRENT AND DEPOSIT ACCOUNTS.****CODE ONE ONLY
IN EACH COLUMN.**

	POSB	Other
No account	Y	Y
Vague, don't remember	X	X
Length of time ago (in the units stated by informant)		

15 How often do you put something in ?
(*VERBATIM*).16 About how often do you take something out ?
(*VERBATIM*).

17 Do you mind telling me how much you have got in your savings account at present ?

	POSB	Other
No account	Y	Y
Up to £50	X	X
Over £50—£100	0	0
Over £100—£250	1	1
Over £250—£500	2	2
Over £500—£1,000	3	3
Over £1,000—£2,000	4	4
Over £2,000	5	5
Refusal	6	6
Savings book referred to	Y	Y
Savings book not referred to	X	X
Card used	1	1
Card not used	2	2

18 Is this more, less or about the same amount as you had this time a year ago ?

	POSB	Other
No account (a year ago)	Y	Y
More	X	X
Less	0	0
About the same	1	1
Don't know, can't remember	2	2
Account book examined	3	3
Account book not examined	4	4

TO ALL:

19 Now have you bought any bigish things or had any big expenses since January 1st, 1949.
If YES, ask for each:

- What article did you buy or for what purpose did you have to spend money ?
- How many did you buy ?
- Did you buy it outright or did you get it on credit or hire purchase ?
- How much did it cost altogether ?
- About when did you buy it ?

FIRST ASK THE QUESTION IN AN OPEN MANNER AND ENTER ALL THE RELEVANT DETAILS, NEXT HAND THE INFORMANT THE PROMPT LIST AND SAY "NOW I WOULD LIKE YOU TO LOOK AT THIS LIST AND TELL ME WHETHER YOU HAVE BOUGHT ANY OF THESE ITEMS OR HAD ANY OF THESE THINGS DONE." PROMPT EACH ITEM ALoud TO THE INFORMANT.

PROMPT LIST

CARPETS
CURTAIN MATERIALS

BLANKETS

DINING ROOM FURNITURE

DRAWING ROOM FURNITURE

BEDROOM FURNITURE

KITCHEN FURNITURE

WIRELESS SETS, RADIOGRAMS

GRAMOPHONES

ELECTRIC COOKERS

ELECTRIC FIRES

GAS COOKERS

GAS FIRES

REFRIGERATORS

BOILERS

WASHING MACHINES

IMMERSION HEATERS

BICYCLES

CARS

PRAMS

DECORATIONS TO OUTSIDE OF HOME

DECORATIONS TO INSIDE OF HOME

Description of article or work (full details)	Number bought D.N.A.	Type of purchase Hire Bought purchase outright or credit	Total cost			Date bought	Items given	
			£	s.	d.		Before prompt	After prompt
.....	Y	3.....4.....	.....	.....	.....	.....	1.....	2.....
.....	Y	3.....4.....	.....	.....	.....	.....	1.....	2.....
etc.								

20 Are you, yourself, making any payments out of your own pocket for any of the following ?

PROMPT EACH IN TURN.

LIFE ASSURANCE

INDUSTRIAL ASSURANCE

PAYMENTS FOR HOUSE PUR-

ENDOWMENT POLICIES

SUPERANNUATION FUNDS

CHASE OR ANY OTHER

MORTGAGE PAYMENTS OR

ANY OTHER PAYMENT OF

THIS KIND.

If YES, ask for each:

- How frequently do you make the payment ?
- What is the amount of the payment for the period you mentioned ?
- About when did you begin to make these payments ?
- Do you know roughly how long you have to go on making these payments ?

Description of policies or payment	How frequently						Amount of payment	Payment started	Payments go on till	Additional comments (Include details of refusal to give any information.)
	Weekly	Fortnightly	Monthly	Quarterly	Half-yearly	Other regular period specify				
.....	1	2	3	4	5	6.....	.....	.....	.....	.....
etc.	1	2	3	4	5	6.....	.....	.....	.....	.....

21 Finally, two general questions about savings.

The Government and the National Savings movement are asking people to save as much as they can. Why do you think it is the Government wants people to save anything ? (VERBATIM)

(a) If ABLE TO GIVE ANY REASON: How do you feel about the Government's reasons for wanting people to save ? (VERBATIM)

D.N.A.9

APPENDIX D
CLASSIFICATION

(i) Interviewer's name
Interviewer's number...../...../.....

(ii) RING DATE OF INTERVIEW.

	Sun.	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.
April	16	17	18	19	20	21	22
	23	24	25	26	27	28	29
	30	—	—	—	—	—	—
May	—	1	2	3	4	5	6

(iii) Subject. Where living.

At homeY
In institution, hotelX
As a boarder0
In rooms.....1
As resident servant2

(iv) Type of dwelling.

Detached house3
Semi-detached house4
Terraced house5
Self-contained flat6
Part of house7
Other (*specify*)8

(vi) Number of rooms

(vii) Subject occupation (full description)

Subject industry, trade or profession

Self employed1
Employee2

S.W.E. occupation (full description)

S.W.E. industry, trade or profession

Self employed1
Employee2

(v) HOUSEHOLD COMPOSITION

Relationship to Subject	Age	Sex M F	Status M S W	Working F P N
A. Subject		1 2	3 4 5	6 7 8
B.		1 2	3 4 5	6 7 8
C.		1 2	3 4 5	6 7 8
D.		1 2	3 4 5	6 7 8
E.		1 2	3 4 5	6 7 8
F.		1 2	3 4 5	6 7 8
G.		1 2	3 4 5	6 7 8
H.		1 2	3 4 5	6 7 8
I.		1 2	3 4 5	6 7 8
J.		1 2	3 4 5	6 7 8
K.		1 2	3 4 5	6 7 8

(viii) Income per week less deductions plus bonuses.

	Sjt.	S.W.E.
Nil	0	0
Up to £3	1	1
Over £3 to £5	2	2
Over £5 to £7 10s.	3	4
Over £7 10s. to £10	4	4
Over £10 to £20	5	5
Over £20	6	6
Don't know	7	7
Refusal, not asked	8	8

If SJT. D.K., REFUSAL, NOT ASKED:
Why ?

If S.W.E. D.K., REFUSAL, NOT ASKED:
Why ?

(ix) Interview situation.

CODE Informant alone
ALL Spouse present1
THAT Other adult(s) present2
APPLY Children present3

(x) Interviewer's assessment of success of interview.

Above average (give reason)4
Average5
Below average (give reason)6
Very poor (give reason)7

(xi) Serial number on record sheet

(xii) Subject education.

Age left school
Type of last school.
Elementary.....Y
Central, Technical, Commercial ...X
Secondary, Public0
University1

Total 0—4

Total 5—15

Total 16 and over

Total in household

Housewife is
(give letter)

S.W.E. is
(give letter)

APPENDIX E

SURVEY RESEARCH UNIT

RECORD SHEET

[illegible]

DISCUSSION ON THE PAPER BY MR. DURBIN AND MR. STUART

Dr. D. J. FINNEY, in proposing a vote of thanks: I am sure that all who have heard the Paper will agree that it is an exceptionally interesting contribution to the art of the social survey.

My qualifications for giving an appreciation of such a paper are slight. Although I have been concerned with many sampling problems in pure and applied biology, I have never taken part in any form of social survey either as a statistician or, knowingly, as a subject. I must confess that my inclination is to keep clear of the statistical and practical difficulties inevitable in surveys of human behaviour, and that my natural stubbornness and unco-operative attitude would probably make me the kind of subject that every interviewer hopes not to meet. Some months ago I remarked to a friend, whose work lies in this field, that I should be a very bad subject in surveys of public opinion and consumer preference, because I should inevitably feel antagonistic to the interviewer who asked questions that to him seemed pertinent but to me impertinent. I was told that, if I refused the first interviewer, a second more subtle inquirer would be sent; if I still succeeded in refusing, a third still cleverer and exceedingly glamorous interviewer would appear, whose wiles I could not possibly resist. Since this conversation I have been anxiously awaiting my selection as a typical member of the public: I would like to offer my name to any Fellow of this Society who may be contemplating a survey.

In view of this declared policy, I am surprised that Mr. Durbin and Mr. Stuart report no interaction between age and sex of interviewer and age and sex of subject in respect of success rates. To me, one of the most striking features of their investigation is the homogeneity within any one team of interviewers. Though the three organizations had rather different rates for favourable responses, they show practically no indication of variation attributable to the individual interviewer within an organization. Perhaps we ought to beware of accepting too readily a belief that such variation is negligible, since the number of interviews conducted by any one person was, from a statistical point of view, comparatively small, especially for the London School of Economics team, in which heterogeneity might be thought most likely to occur. Nevertheless the results of the investigation are certainly very encouraging from this point of view.

One of my major interests in the theory and practice of sampling has been the study of systematic sampling and the comparison of its efficiency with that of random sampling. I am ready to believe that, for surveys of the kind that we are now considering, the convenience of systematic selection is great and the danger of ill-effects small. Nevertheless, I have been sufficiently surprised in the past by disturbance of the efficiency of systematic sampling resulting from an unexpected periodicity to wish that Mr. Durbin and Mr. Stuart had discussed the question of sample selection more completely. In particular, their comment that the only consequence of systematic selection may be "a slight amount of stratification" is unfortunate in its suggestion that stratification is an undesirable characteristic of a sample, produced only when selection is systematic. Stratification in itself, of course, is not inconsistent with random selection, and is indeed a device often introduced in order to increase the precision of a random sample, but the form of stratification introduced by systematic choice of individuals at equal intervals may destroy the validity of error estimates.

Mr. Durbin and Mr. Stuart have noted that factorial design has been little used in social surveys. It is worth remembering that, as long ago as 1942, in an account of sampling from U.S. Census records, Tepping, Hurwitz and Deming described the use of what they termed deep stratification. In current terminology, this might rather be considered as fractional replication of a factorial scheme. In analysing data from a factorial design, whether this be an experiment or a sample survey, I suggest that it is helpful to distinguish between analysis of variance and assessment of significance. The strict validity of the significance tests usually employed depends upon normality of the distribution of errors; even if this condition is not fulfilled, the analysis of variance is valuable as leading to estimates of the variation from different sources, provided only that the components of variation can be represented by an additive linear model.

I want to ask the authors of this paper for further information on two points. In their study of differences between interviewers from one organization, they use a χ^2 test from which effects of lack of balance over questionnaire, and over age and sex of subject, have been removed. I should be interested to know how this was done. Unless the allocation of subjects to interviewers conformed to some very simple plan, the test seems likely to involve problems of statistical technique such as Cochran discussed in a recent issue of *Biometrika*, and any further ideas on these would be welcome. Secondly, I find the age effect in Table 9 so surprising that I am anxious to see a more detailed breakdown into age-groups. This might be done for both sets of L.S.E. interviewers, even though the subdivisions had to be at rather higher ages for those not in the main design.

I must close on a note of complaint: the end of this paper comes much too soon! Mr. Durbin and Mr. Stuart have whetted our appetites by a most interesting account of the manner in which

1951]

the response rates of subjects were affected by the various factors studied. Some of us may be impressed by the large effects attributable to organizations and to the category of subject interviewed; others may be relieved that these differences are no larger. All, I am sure, are most anxious to follow the story to its conclusion, and to learn how far the character of the replies depended upon the nature of the interviewer and his organization. This part of the investigation is likely to be even more valuable and more interesting than what we have heard this evening. I would hazard a guess that differences between organizations in respect of the answers they obtained to some of the more difficult questions will prove to be at least as great as the differences in success rates shown in Table 3, and may therefore be vitally important for the interpretation of a survey. However, we cannot have the main course of our meal this evening, and must instead look forward to having it served to us at some early future meeting.

I want to express to Mr. Durbin and Mr. Stuart my personal thanks for this paper, and I have no doubt that all present will join me in support of a motion that a very hearty vote of thanks be accorded them. I should like also to congratulate Professor Kendall and his Division of Research Techniques on choosing, for one of their first studies, the performance of a piece of research that has been needed for a long time past and will be remembered for a long time to come.

Mr. R. F. FOWLER, in seconding the vote of thanks: Following Dr. Finney I should perhaps explain my own lack of qualification for seconding this vote of thanks. The only reason I can think of for being asked to do so is that more than ten years ago, with two colleagues, I helped to found what was then called "The Wartime Social Survey". Both my colleagues and I would have been classed as inexperienced, although we used professional, experienced interviewers.

The paper we have heard is important not only for the valuable results of what is intentionally a limited experiment, but also for the elucidation of the way in which technical methods, developed in other fields, can be applied to problems which are increasingly urgent in the field of social surveys. The real worry of those responsible for social surveys is not so much the sampling basis as the possibility of hidden bias, especially in those inquiries designed to extract information directly from human beings by question and answer. It is encouraging to know that Professor Kendall's Division has got down to the job of tackling this matter, and it is much to be hoped that this paper is the first of a series of studies on the nature and magnitude of bias encountered in social survey work. The authors are to be congratulated on the clear way in which the results of their investigation have been presented, and for giving all the details—or almost all—required for a critical appreciation of their work. It is particularly useful to have the questionnaires reproduced in full detail in the Appendices.

There are a number of points to which I should like to refer, and on which, possibly, further explanation will be given. Two or three of these relate to Table 3 and statements on p. 176 where the authors say that the easier questionnaires were more successful than the difficult, and I assume they mean easier for the interviewer. I am not clear whether the tuberculosis questionnaire was more successful because it was more interesting, or because it was confined to matters of opinion rather than matters of fact which made it easier for informants to answer. Differences between the questionnaires would depend on several factors which have not been distinguished in the design. No doubt further light will be thrown on this question when the analysis is available.

The authors state, also on p. 176, that "the lower class boroughs are more responsive than the middle class". This is based on a significantly higher success rate for Bermondsey, since the lower refusal rate is shown to be significant. Is not the higher success rate for Bermondsey, compared with that for Wandsworth, due to the significantly higher "gone away" rate for Wandsworth?

The most striking result of the inquiry is the significantly lower success rate and the higher refusal rate for the students. It is important that the reasons for this should be established. The paper is entitled "Differences in Response Rates of Experienced and Inexperienced Interviewers", but I am not sure that it would not have been more correct to describe it as "Differences in Response Rates of Inexperienced University Students and Professional Interviewers". It by no means follows that what is true for students is also true for other classes of non-professional interviewers. I should like to know how the students introduced themselves; did they say they were university students; and even how were they dressed? The differences may be due not to lack of experience, but simply to the fact that the students were obviously students, and that some people are allergic to quizzing by students. This question, however, should not be difficult to answer in another inquiry, and I am glad that it is proposed to study the subject further.

More interesting and to me more puzzling is the significantly higher "gone away" rate recorded by the students. Perhaps there is some point which I have overlooked, but I cannot think of

any possible connection between the "gone away" rate and the class of interviewer. Is it possible that "gone away" does not always mean what it says, but is in some cases a more polite way of refusing to give an interview? This might explain why there were fewer "gone aways" for the tuberculosis questionnaire. It would be interesting to have the success and refusal rates shown as proportions of the number of persons with whom contact was actually made rather than as proportions of persons associated with the sample. The low success rate for Wandsworth was obviously due to the high "gone away" rate. Would the difference between the three boroughs be significant if successes were shown as a proportion of the sum of successes and refusals?

Finally, I should like to draw attention to what I think is a printing error. On p. 178 it is stated that it appeared that the students as a class were less successful than the other organizations in obtaining "completed" questionnaires. I am not sure whether this is a printing error, since success was defined as including all cases in which the questionnaire was wholly or partially completed? It is likely, I think, that the main difficulty is to persuade people to answer any questions at all and that the percentage of uncompleted questionnaires is generally small. But this particular question is more properly dealt with in the question of the second of the two factors governing the accuracy of the survey, that is, the quality of the information collected, and I shall look forward with considerable interest to the further report on this.

Mr. LOUIS MOSS also welcomed the paper, which he hoped marked a deepening interest in the methodology of social research in academic circles in this country. It was a curious fact, as the records of this Society showed, that many of the contributions to social research in this country had come from people who were not members of universities, and indeed there were still many universities to-day which did not regard empirical inquiry in the social field as a respectable area of work for university staffs. He was sure that all those concerned with what might be called applied social research in government, commercial organizations and elsewhere would be heartened by this evidence of a new interest, and would do their best to help this new division and others like it which, it was hoped, would develop in other academic centres.

As was to be expected in a first study in a new field, the paper threw open many questions outside its immediate purpose. Indeed, from some points of view it contributed more by its indications of the kind of issues which ought to be studied than by its actual conclusions on the particular points covered.

Some of the conclusions should, he thought, be used in an extremely tentative way. Because of the conditions of the experiment it seemed highly likely that they were not firm indications of what was to be expected in the general run of such work.

For example, it was said that there was no evidence of marked heterogeneity amongst individual investigators. It had, however, been found as a result of experimental work at the Social Survey that differences between investigators, certainly in some fields of work, did exist. An analysis of the results of over 100 interviewers each carrying out between 40 and 100 interviews showed that one group completed 550 interviews with no refusals while another small group had a refusal rate of over 12 per cent.

In the same way it appeared from the present results that age of investigator had little effect on the results obtained. At least one Social Survey inquiry had demonstrated that the age of investigator was related to the results achieved.

No doubt such differences in results of experiments were to be expected until we knew more about standardizing our methods of inquiry.

But so far as the present paper was concerned there was, he thought, a rather more serious point to be made. Some reference was made to the need for compromise between the methods of the different organizations concerned in order to reach an effective design for the inquiry. Owing to these compromises the results, on the one hand, were not those to be expected when these organizations were using their normal methods of work and, as the paper pointed out, because of this the results probably underestimated the difference between experienced and inexperienced investigators. On the other hand, it was not possible for the design of the experiment to take into account many known differences in approach and method, and the results reflected these differences in an uncontrolled way. This meant, he thought, that we must be even more cautious about generalizing from the data given.

Thus Table 16 gave the percentage success of outstanding cases on the first, second and third call. It would be seen that the Social Survey figures gave a lower rate of success for the first call, but higher rates for the second and third. As a Government organization the Social Survey had to be extremely circumspect in its relations with members of the public. At no time were its investigators allowed to insist upon interviews at the inconvenience of the informants. Consequently they were trained never to press for interview on the first call, and wherever possible to make arrangements for interview at some time convenient to the members of the public concerned.

1951]

On the other hand, they were trained to go out of their way to persist in their efforts to obtain an interview at some later stage wherever this could be conveniently arranged. This was necessary in order to maintain an acceptable success rate, but it did, he thought, effect the results of the kind of analysis made in Table 16.

Indeed, one should be extremely cautious about using success rates as an indication of successful interviewing. After all, making contact with the informant was only the first part of the interviewer's job; the second was to collect usable information.

The authors of the paper expressed the view that these two sides of the interviewer's work were essentially distinct and could be treated separately. Mr. Moss dissented very sharply from this view. It seemed to him that the value of information collected in the course of an interview might be very seriously affected by the way in which contact has been made with the informant, and by the impression made upon him when the interview was arranged. Unfortunately, there was no material in the paper dealing with the content of the interview, and until we could assess the effect on the material collected of the factors dealt with in the paper, he did not think we could say that we were assessing success in interviewing.

This point could, he thought, be made clear by a *reductio ad absurdum*. It would theoretically be possible to reduce refusal rates to zero by supplying investigators with machine guns. He doubted, however, whether Treasury approval could be obtained for such methods, and it was probable that the quality of the material collected would be affected by this method of achieving a high success rate.

This led to his last point, which related to the main object of the paper. The aspect of interviewing covered in the paper was part only of the interviewer's work. Where a method of sampling was used such as the one involved in this design there was a certain amount of control over investigators, and in a short time, after two or three weeks' work, most investigators could become fairly proficient at carrying out such sampling instructions. The results presented in the paper did not help to assess differences where less controlled sampling methods were used. Training investigators to carry out an interview, however, might present rather more serious difficulties. Indeed, the primary problem here very often seemed to be to train people to keep themselves and their personalities out of the interview, to reduce the effect of their own personal intervention to a minimum. This might be more difficult where people had highly developed ideas of their own, and university students might therefore be more difficult people to train for interviewing the general run of members of the public than people with a lower educational level. There was also the point that students were a mobile population, and it was unlikely that they would be available for a long stretch of work in the field so that the experience they gained in one or two inquiries would be not available for use in later inquiries.

This difficulty was not limited to students, but probably applied to any *ad hoc* organization, and indeed to any investigation where field staffs were used for interviewing and collecting information from the public for a limited period only after having been drawn from different duties. In this sense he thought that results of further analysis on the more difficult and important part of the interviewer's job, i.e., collecting the material, would support the conclusions of this paper, that a student interviewing staff would not be likely to produce results of the same level as those of investigators with a fair amount of training, or experience, or both.

Whatever one thought about the limitations of the conclusions drawn from the paper, the most important point was that at last we had a division of a university making it its business to investigate these matters. Mr. Moss hoped this would be the first of many papers from the new division, and that the others would tackle their problems in the same objective and scientific spirit as had been shown by the authors of this paper.

Dr. MARK ABRAMS said that those who earned their living by employing interviewers had long wanted some organization to undertake precisely this kind of technical research; they were very grateful for this paper and hoped there would be others.

This particular topic was one which interested him greatly. Normally the amount of preparatory work that went into producing a "trained interviewer" was comparatively extensive and expensive. People were given a basic training, and then specifically prepared before being sent out on each survey; in the "field" they were supervised and closely checked. The paper described an experiment which held out the possibility of short-cutting much of this training and using untrained interviewers. Naturally his organization turned very hopefully to the results, since they might point a way to reducing the cost of social and market surveys without any loss of efficiency. It was, therefore, with much disappointment that he read the conclusion that students were inferior to the interviewers of the two professional organizations. From that it seemed as if this short cut to economy would have to be written off, but he was not sure from the material presented in the paper that the authors had been altogether fair to the untrained

interviewers; perhaps there was additional material which would throw a little more light on their efficiency.

The points he picked out on which more evidence was needed were as follows: on p. 171 it was stated that the average student probably did less than 12 interviews. Many probably did a good deal less than 12, and this was not a fair test of any interviewer, whether trained or untrained. In most large-scale surveys the normal procedure was to regard the first 10, 15 or even 20 interviews turned in by each interviewer as being more or less trial shots; they were still learning the particular approach needed for the survey. The test described in the paper expected them to learn three different approaches within the course of 12 interviews; this was an unreasonable handicap, and it would be interesting to see if the success rate of the students improved after, say, the first six interviews.

Another point, on p. 172, was that "success" had been defined as all cases where the questionnaire had been partially completed. He was sure that under "real" conditions that would not be regarded as success in any of the organizations which participated in this experiment; to them a success would mean that the questionnaire had been fully completed. If there could be some indication of the proportion of partially completed questionnaires from the students as compared with the proportion of partially completed questionnaires from the experienced interviewers it might throw some light on this point.

The material on pp. 182-183 raised the question of the time at which the interviewing was done. One of the things which surprised him was that the students, by choice or accident or force of circumstances, were, in fact, doing their interviewing at times which normally were regarded as the most productive. They had tended to concentrate their work in evenings and week-ends; in spite of that selection of the most favourable times they had a decidedly lower success rate.

Finally, there was something he would like to raise in connection with the paper as a whole. The paper was concerned with the efficiency of untrained interviewers. Efficiency was essentially a cost concept, and therefore any measure of efficiency must be in terms of monetary expenditure or time expenditure, with the time being translatable into a money figure. There was nowhere in the paper any indication of time cost or money cost. He thought it should be possible from the material collected to tell if there was any difference between the untrained and the trained investigators in the amount of time spent on completing an interview, and, secondly, if there was any difference in the length of time spent on completing, say, an assignment of 12 interviews. In the last resort the professional organizations had to consider efficiency in terms of cost, and that must be considered in a study of this kind. From the cost point of view the expensively trained interviewer might be cheaper and more efficient than the untrained.

Dr. H. DURANT said that the questionnaires were handed over for tabulation at a stage at which they would not in the normal course have been handed over for analysis. There had been none of the very important editing which was always carried out with, if necessary, re-calls by the interviewers.

Secondly, in all the questionnaires in this experiment provision was made for recording the circumstances of the interview, whether other people were present, or whether the interviewee and interviewer were alone. In his own organization strict instructions were always given to interviewers that they must interview a person alone. The point was important, since there was evidence that the presence of a third party had a decided effect. It was a subject which suggested itself for examination in further experiments carried out by Professor Kendall and his Unit.

Thirdly, there was a difference in the selection of the interviewers by the British Institute of Public Opinion and by the Social Survey. He had always been a heretic on this matter. He had always held that everybody might become an interviewer, which was not the view of many people who worked in the field of social surveys. His organization took most people who offered themselves as interviewers. They were given trial work and if they did it badly they were dropped. Otherwise they learned as they went along, corrections and suggestions being offered in the course of their work. In the Social Survey the interviewers had to go through a process of selection and training and could be regarded as fairly highly trained.

It was not simply a question, therefore, of experienced *versus* inexperienced, but of selected, trained interviewers *versus* the non-selected.

He would also comment on one of the implications of the findings. With random sampling of the total population there must be a very heterogeneous list of persons to interview. The results showed that consequently it was a waste of time to interview before 2 o'clock, or even before 5 o'clock. The implications were very important for efficient organization of surveys. If full-time interviewers were employed on random sampling they must fill in their time somehow; they must make calls during the day, and they could not always select whom they should call upon because of the difficulties of routing. It seemed to him much more efficient, in using inter-

1951]

viewer resources, if interviewing were started after 2 o'clock, and preferably even later, in the evening. Whilst that was desirable, it meant employing a large number of interviewers in order to get through the work within a reasonable time. Hence, it would also involve considerable changes in the administrative structure of research organizations here and in America.

Roy Morgan, the Gallup Poll Director in Australia, had been experimenting with a method of random sampling, the central characteristic of which was that all the work must be done in the evening. He had been in correspondence with Morgan with regard to modifications in the scheme. If they were made it looked as though it would be a method of random sampling which was cheap to operate and speedy. But it depended very much upon using a large number of interviewers, all working in the evening.

The paper asked why the students' success rate should be lower than that of the other interviewers. He thought that research organizations themselves could answer that. They saw interviewers starting as very inexperienced and becoming very experienced, and almost the only development in their work was their rate of success in making contact.

He would like to say something which perhaps he was freer to say than others. Complaints had been made that this paper was only the *hors d'oeuvres*. If the complaints were justified the explanation was that the paper had been delivered earlier than was originally planned. All the other analyses were now completed. He and others present had seen them. They showed differences between the performances of the interviewers, which were not all in the same direction.

One conclusion clearly emerged—and it would be a comfort to clients who ordered research—that in spite of the differences in the success rates of the organization, in spite of the differences in success in completing the forms, when the results achieved by the three sets of interviewers were compared with each other there was practically no difference. The differences were so slight that Professor Kendall was throwing together all the results on each questionnaire when analysing the answers for sociological purposes.

Mr. TOM CAUTER said that the professional survey organizations welcomed this paper, for although many problems remained, especially in the use of more economical methods, much work had been done and much experience gained. An excellent paper in the field of sampling had been given to the Society recently by Mr. Gray and Mr. Corlett, and it was hoped that they and others would continue to contribute to the general fund of knowledge in this field.

Many people had been more worried about the inaccuracies and bias likely to result from the interviewers themselves. To-day's paper, taking first things first, gave a clear guide to the performance, in terms of response rates, of different classes of available interviewers. The authors had given some interesting data which might have repercussions on sampling practice. Much had been said about the value of random sampling methods. Little that had been said in their favour was in serious dispute, apart from questions of practicability and cost. The main value in much of the work must be that one could assess with a high degree of probability the likely limits of statistical inaccuracy. Even with the two more experienced professional organizations there was an important rate of failure in making contact with the members of the original sample design. As a matter of interest he had examined the records of two national surveys carried out on quite a large scale under sampling conditions much like those exposed here, and he had not found any significant difference in performance; his organization did get a rather higher rate of people "unsuitable for interview", but this might well not be significant. In this connection there was some difference between districts. While the importance of this failure would differ greatly according to the nature and scope of the survey, the problem of substitution must cause many people to doubt validity in many cases of the arguments in favour of random sampling in the human survey field. He was not attacking random sampling, but trying to make clear a point that some sampling which was described as fully random might be vitiated by this important failure to contact in full the original sample.

The present paper was the first step in dealing with the problem of interviewers. Could they hope for similar valuable assistance in some of the more difficult aspects of interviewer bias? A comparison had been given of the performance of investigators with different backgrounds in similar circumstances; could a greater success be attained by better training, and could the results of new methods of training and supervision be demonstrated in the way seen in this paper? The completion of a questionnaire was not the final standard by which a successful interview could be measured, and he would like to see work on the accuracies, inaccuracies and subjective bias involved in questionnaires of different types used by different field workers. The way in which questions were put and the different attitudes taken by different workers in interpreting different answers might prove to be one of the more serious sources of error, as well as one of the

most difficult problems to face. Little was known about checking and remedying "accidental dishonesty".

Several speakers had referred to the percentage of success obtained on successive calls. In Table 15 it was noticeable that the Social Survey and the other professional bodies achieved different success rates on call 1 and call 2. His own organization had taken out, on a national survey, the percentage of success obtained by successive calls, and there was no significant difference between themselves and the Government survey. The terms of day working were comparable with the Social Survey rather than with the British Institute of Public Opinion.

This Division was doing a service to the professional people in the field as well as the University bodies.

Mr. T. CORLETT said that the points he wished to make concerned the way in which the information was recorded for the purposes of this experiment, because, if he might expand the authors' remarks in the first paragraph of the paper, the accuracy of the results depended very largely on the way the information was recorded. A specimen of the record sheet was given on p. 195. The results of each call were recorded by the interviewer ringing one of five pre-coded answers.

Experienced practitioners would know that there were three main dangers in using pre-coded answers of this type unless they were carefully tested beforehand. The first was that some answers did not fit into the pre-codes; the second was that once an answer had been recorded in the pre-code form it could not later be subdivided; and the third, that one often had difficulty in interpreting some of the pre-coded answers. It seemed to him that the authors had to some extent run into all of these difficulties. For instance, the groups used in the analysis of the results of the calls were detailed on p. 170. It could be seen there that the five pre-codes had become seven in the analysis. The last two items listed on p. 170 were not, in fact, covered by the pre-code at all, so that information about subjects unsuitable for interview and untraceable addresses was based on what was added to their record sheets by the investigators. When this kind of thing happened one always had a lurking suspicion that one had not got the whole story: one wondered how many interviewers had decided to write in notes about the special cases they dealt with, and how many had decided to force them into one or other of the pre-codes.

The second danger, the inability to subdivide a pre-coded group, was well illustrated by the case of refusals. The ringed "2's" on the record sheet (indicating a refusal) were doubtless very easy to count, but in the end the readers of the paper (and, he gathered, the authors) were still left wondering *why* the students got 13½ per cent. refusals. If interviewers had been instructed to write in a description of the circumstances of the refusal, which was the Social Survey's standard practice, more light might have been thrown on this point.

He now came to the third danger, that of wrongly interpreting a pre-code. He would refer to the authors' statement that the Social Survey investigators' greater success at the second call did not arise from the greater number of appointments made. It rather seemed as if the authors had forgotten their definition of the pre-code "appointment made". This definition was not given in the paper but was to be found in the interviewer's instructions, which were also not given. The instructions read as follows: "Code 4 (that is, 'No appointment made') will apply only when a call results in absolutely no supplementary information becoming available to the interviewer which helped in fixing the time of the next call". So that within the very wide terms of the corresponding definition of an "appointment" it seemed quite possible that the more experienced Social Survey interviewers had succeeded in making more definite appointments. This might well explain their greater success.

In conclusion, he felt that the authors themselves would probably agree that these flaws in their experiment were perhaps due to their lack of practical experience in work of this kind. If he might dare to point a moral he would express the hope that in their future work the authors would not allow their obvious skill and interest in methods of analysis to distract their attention from the care necessary in the actual business of recording the information.

Mr. J. L. WILLIAMS had one point to make. In the introduction the authors stated that there were two main factors governing the accuracy of surveys, (1) the representativeness of the sample, relative to the desired population, and (2) the quality of the information collected. He was glad to see that they immediately proceeded to add a third factor—the quantity of the information collected.

By including three surveys of different length, it had been possible to show the effect of this third factor upon response, and hence probably upon the representativeness of the samples. But all three surveys were of the single interview type. Had resources permitted the inclusion of an even more lengthy survey (of the weekly log book type) the differences in response might have

1951]

been even more striking. Subsequent analysis would show the effect of the size of the survey upon the quality of information collected.

It would be of practical value to those planning fieldwork to know whether the interviewers who were successful in a short survey were different from those who were successful in a long one. This meant examining the response obtained by individual interviewers relative to the size of the survey. He did not think this point was covered by the IQ interactions in Table 4, which dealt with normal groups of interviewers. He hoped it would be possible to answer this question in the work which was promised.

Mr. J. I. MASON felt that the dates and time intervals were always important to the interpretation; e.g., was the time taken by the London School of Economics interviewers the same as that taken by the professional organizations (relevant to Table 15)? Again, both refusal and "gone away" rates might vary with the time of year. The "gone away" percentage in Wandsworth, which was so uniform for the three organizations and was at so high a rate, made him wonder whether some defect was not latent in the local records used.

Deeper analysis of the "refusals" and the "gone aways" might also bring something to light. Further research might check whether a difference of quality existed when interviews were made in the evening instead of during the day.

He had always been worried about the use of variate transformations and the value of relying on tests of "statistical" significance in this practical work. If the variate were discontinuous and ranged only over a small number of finite values, working to two decimal and to 1 per cent. or 0.1 per cent. confidence levels would seem to need considerable further justification before subjective judgments could be cut out.

But this pioneering experiment was a great advance towards helping Market Research find the best compromise between theory and practice; between speed, cost and accuracy; between the science of limiting the sampling variation in practical experiment, and the need, which always remained, for the super-imposition of judgment, allowing for non-figure aspects and practical bias which might always be present.

Mr. Mason subsequently wrote:

Gray and Corlett (in this *Journal*, 1950, p. 167) indicate a weakness in the records where people move within the district but do not change their retailers for rationing. Does this not contain a possible source of accumulating error each year, dating from the time when a new ration book issue is completed in May? The records were apparently sampled in March, and 10 months might make a considerable difference, especially in some districts. Could D.S.T. or the Social Survey analyse the percentage of the registered cards in each district of the country for which the address is altered but no transfer from the district occurs, (a) for the period of the ration book issue, (b) on average for the rest of the year? In districts where variation is marked and high, some doubt might be thrown on the use of these cards for sampling purposes.

No objection is raised to significance tests as a first check in the statistician's assessment of what is really significant; but are not significance levels tending to-day to be used to displace subjective judgment and deep analysis of the detailed material? This seems dangerous, from experience, on material which cannot be controlled as fully as in the laboratory, and for which one has no guarantee that the saving grace of quasi-normality exists.

Mr. W. F. HARRIS wished to make three small criticisms. He was surprised at the lack of interaction between the age and sex of the interviewer and interviewee. It called to mind a Government Survey which inquired whether ex-service men wanted their medals or not when it was found that the response varied considerably with the age and sex of the person putting the question. He wondered whether there was not some interaction between the age and sex of the questioner and the nature of the inquiry.

That led him in turn to doubt whether the scope of the subject-matters of the various inquiries was adequate. They varied in the degree of complication from the interviewer's point of view and from that of the victim, but did not seem to vary sufficiently in the colour of feeling they aroused in the person being interviewed.

He would make a plea on behalf of the small-scale commercial statistician, working with a comparatively small staff on a great variety of inquiries, for some means of allowing Fellows of the Society access to the working papers so that they could see the methods of accumulating these findings into a cogent conclusion.

The following written contribution was received after the meeting:

Mr. J. A. REECE: A few points of experience in the commercial field, although restricted to the special case of a gas undertaking, may possibly throw some light on the general explanation

VOL. CXIV. PART II.

of the investigation apart from the mathematical analysis. Best results are obtained from spells of interviewing by members of the permanent inside market research staff. The more academic members cannot maintain a high performance for as long a spell as can the remainder. The differences in accuracy and speed are very great between one member and another. It is sometimes necessary to use a slower but more intelligent interviewer for difficult subject-matter. Long and careful scrutiny of the returns as they come in, and talks with the interviewers, are the most important factors in getting satisfactory results.

The authors subsequently replied in writing as follows:

The main point in the discussion was that a full assessment of the performance of the interviewers must await the qualitative analysis of the information collected. We entirely agree. A report on this aspect of the inquiry is now being prepared by our colleagues, Mr. Booker and Mr. David, and will be published shortly. We shall accordingly confine ourselves to points not dealt with in that report.

We assure Dr. Finney that we did not intend to question the benefits of stratification, deliberate or otherwise. We did not discuss the sample selection more thoroughly because Gray and Corlett had already dealt with it very fully in the paper referred to in the text.

The modification to the χ^2 dispersion test seems to us a fairly simple one. In the usual test of the proportions of success in a number of samples it is assumed that the chance of a success is constant within the same sample. Suppose, however, that each sample is divided into two parts with different probabilities in each. If the overall probability of success is held constant, the variance of proportions between samples will diminish. (This is in effect a "Poissonian" extension of the binomial scheme.) Consequently, in estimating the theoretical variance from the overall proportion it is necessary to deduct an amount depending on the differences in the probability of success between the two parts into which each sample is divided. This is fairly easily done if, as in our case, the two parts are of equal size and the difference of probability between them can be assumed constant from sample to sample.

Since this particular analysis has aroused so much interest, it is worth mentioning that the test we have used is likely to give a rather conservative test of homogeneity. It was not possible to ask interviewers to work in more than one district, with the result that the between-interviewer comparisons were confounded with the between-district comparisons. This did not invalidate the comparisons given in Table 3 of the paper since the emphasis there was laid on organizations rather than on individual interviewers, and each organization was equally represented in the three boroughs. It did mean, however, that in comparing the performances of interviewers of the same organization, proper allowance could not be made for between-district differences which, to err on the safe side, were therefore assumed to be zero for this purpose.

The additional analysis by age groups of the London School of Economics extra volunteers requested by Dr. Finney is given below. To make the numbers in the two groups comparable, the dividing line had to be put a year higher than for the interviewers in the main design.

	Age	
	-20	21-
Number of interviews	270	290
Success	67.0	69.7
Refusal	12.2	14.8
Non-contact	8.1	7.2
Gone away	8.9	7.6
Unsuitable for interview	1.9	0.3
Address untraceable	1.9	0.3
	100.0	99.9

It is very satisfactory that these figures do not support the rather surprising conclusions suggested superficially by the corresponding results given in Table 9 of the paper. They must, however, be regarded cautiously since the interviews were not balanced so carefully by questionnaire and by age and sex of subject as were those in the main design.

Mr. Fowler has raised a number of questions concerning the higher success rates on the tuberculosis questionnaire and in Bermondsey, to which we do not know the answers. As he

1951]

suggests, the higher success rate in Bermondsey may be due primarily to the lower mobility of its inhabitants. Nevertheless this does not diminish the significance of the whole result.

The problem of explaining the students' "gone-away" rate is rather difficult. The Registrar-General has kindly checked, for practically all cases, which of the subjects were in fact resident at the addresses given at the date of the enquiry. The results were:

	"Gone-aways"	At Address Given	At Different Address in same Area	Removed from Area
S.S.	23	9	3	11
B.I.P.O.	35	15	1	19
L.S.E. (main design)	50	25	5	20
L.S.E. (extra)	43	28	5	10

Our definition of "gone-away", which included temporary stays away from home, makes interpretation difficult, but it seems likely that the students' gone-away rate included a greater proportion of concealed refusals.

A number of speakers questioned our classifying as a "success" an interview in which the questionnaire was only partially completed, and in the face of it this would suggest that high success rates could be obtained when only a few questions had been answered. In fact, however, there were only two cases of an interview being terminated part-way through the questionnaire, both due to the intervention of other members of the subjects' family. In addition there were, of course, frequent omissions of answers to particular questions, but these are more appropriately dealt with in the second report.

Mr. Moss has pointed out that the lack of marked heterogeneity among individual investigators in this inquiry does not imply that no differences will be found in other fields. We would agree with this but claim nevertheless that the differences found in our own inquiry are much smaller than many people would have expected. The important point is not so much that there were no differences at all but that such differences as there were, were swamped by the heterogeneity of the population of subjects. To state a range of failure rates is not enough by itself to establish heterogeneity; it must be related to the range that could be expected from chance variation in a homogeneous set. This is, in fact, what the χ^2 test does.

We are in full agreement with many of Mr. Moss's remarks on the limitations of the enquiry.

Dr. Abrams is, of course, right in saying that nine interviews per person is a very small number on which to assess ability, if by this he means long-term ability. This, however, was not our object. We knew that professional organizations could afford to throw away the first batch of interviews from a new investigator. But with volunteers the situation is different. It is often easier to persuade a large number of volunteers to carry out a small number of interviews than *vice versa*. It was therefore the success rate on the first batch of interviews that we were particularly interested in.

We did not devote much attention to the analysis of interviewing costs, since when volunteers are used this is not a very important item. In retrospect we agree, however, that comparisons of time spent would have been of interest, and we regret that our records do not permit them.

In speaking of editing Dr. Durant was no doubt thinking of the editing that would normally have been carried out by the staffs of the two professional organizations. The questionnaires were, of course, edited by the D.R.T. before coding, though it is true that no recalls were made. In addition most of the students were interrogated as they handed in their questionnaires.

We should like to thank Mr. Cauter for his interesting remarks on interviewer bias and we hope that his suggestions will be followed up.

Mr. Corlett has put his finger on a defect of our record sheet that soon became evident in the field. Fortunately all the interviewers had been well briefed to make a full record of any difficulties that were encountered, so we were able to sort out most of the cases without much trouble. We are grateful for his comments on the definition of "appointment made", which help to clarify the discussion given in the text.

We do not share Mr. Mason's doubts about variate transformations in general. It is, however, debatable whether much was gained in this particular inquiry.

Unfortunately, we do not think that our results throw any light on the interesting question raised by Mr. Williams.

We should like to thank the contributors for the wide range of topics discussed, and for the cordial reception given to the paper.

As a result of the ballot taken during the meeting the candidates named below were elected
Fellows of the Society:

Colette Cassagnol.
Henry Claude Cottrell.
Harry Frank Downton.
Colin Russell Furlong.
Jose Gil-Pelaez.
Ronald Henry Johnson.
Brian Arthur Maguire.
Franz Monfort.
Mohammad Shafi Niaz.
Denis Gregory Nickols.

Reginald Henry Nutting.
Sidney James Perry.
George Michael Polyani.
Robert Richards.
James McIntyre Runcie.
Edward Arthur Salmon.
Thomas Francis Sutton.
Herbert Tetley.
John Edwin Thomas Walker.
Boris Alexis Yashanoff.

1951]

NOTE ON THE EXTENT OF THE PUBLIC SECTOR OF THE ECONOMY IN RECENT YEARS

By T. M. RIDLEY

I

1. IN this note an attempt is made to measure the relative sizes of public and private enterprise in this country at the present time, and to show how these have changed since the end of the war.

2. In order to measure the extent of public enterprise different criteria of size might be used, such as the output of goods and services or the input of all or any of the several factors of production employed. When size can be reflected in so many different ways, the use of the various criteria cannot be expected to give identical results.

3. In the second section of this note, the criterion used is labour employed in Great Britain, and the basis of the analysis is the man-power figures published by the Ministry of Labour and National Service. The volume of employment is probably one of the most significant measures of the importance of public enterprise, and at the same time it is also the best statistical basis on which the relative size of public enterprise can at present be estimated.

4. In Section III an attempt has been made to estimate the proportions of public and private enterprise on the basis of output. The figures used relate to the value of net output including depreciation and cover the whole of the United Kingdom. For the purpose of measuring the extent of the public and private sectors as they were constituted in the middle of 1950, figures had to be used relating to the calendar year 1948 (or to the financial year most closely coinciding with it), this being the latest year for which reasonably complete information was available.

5. There are many difficulties in attempting to define the public sector of industry, but it is thought that the undertakings listed in the Appendix would be generally accepted as its major constituents. Small undertakings such as the National Film Finance Corporation and the National Institute of Houseworkers have been omitted; their inclusion would make no significant difference to the totals. The whole or part of any undertaking which is represented by activities overseas has also been excluded.

6. The undertakings have been grouped in order to distinguish those forming part of the machinery of Central Government, those forming part of the machinery of local government, and those other public undertakings which are largely autonomous. The Navy, Army and Air Force Institutes are included in the first group since ownership and control are vested entirely in the three Services. The County Agricultural Executive Committees' industrial employees are included in the same group to avoid separation from the non-industrial employees who have temporary Civil Service status. New Town Development Corporations, which are very small undertakings, have been included in the local government group, since their functions are closely allied to certain functions of local government, and at some stage in the Corporations' histories these functions or what remains of them may be expected to pass to the appropriate local authorities.

7. The Civil Service establishments included in the first group cover all activities carried on directly by Government Departments. Apart from the non-industrial activities which are fairly well known, they include a wide range of industrial activities, among which may be mentioned forestry, shipbuilding and manufacturing in the Royal Ordnance and Post Office factories and in the Royal Mint and Stationery Office establishments. Among the services performed are those connected with the Post Office Savings Bank, the Postal, Telephone and Telegraph services (including the socialized part of Cable and Wireless Ltd.), the State Management Districts, Kew Gardens and the Festival of Britain.

8. The local authorities in the second group cover all trading and non-trading activities carried on directly by local government bodies such as county, borough, urban district and rural district

councils, and drainage, catchment, fishery and burial boards. The various activities include the operation of workshops for the blind, slaughterhouses, waterworks and transport systems, the undertaking of building and contracting, and the provision and maintenance of such services as education, police, fire brigades, baths, libraries, markets, parks, cemeteries, museums, race courses and many others.

II

Employment in Public and Private Enterprise in Great Britain

9. Total employment in Central Government organizations is based on figures published in the Civil Estimates, in the Digest of Civil Service Staff Statistics compiled by H.M. Treasury, and in the *Monthly Digest of Statistics*. In accordance with current practice, part-time workers are counted as full units. Total employment in local government is an estimate based chiefly on information contained in returns rendered to the Ministry of Labour and National Service under the Undertakings (Records and Information and Inspection of Premises) Order, 1943. Employment in other public undertakings is estimated on the basis of material obtained in a variety of ways—from the statistical publications or the annual reports of the undertakings themselves and from official and confidential sources. Estimation was involved in making incomplete or out-of-date figures usable.

10. The industrial analysis of employment in these three groups presented some difficulty, and as no great degree of accuracy could be claimed for the detailed results, figures are presented only for broad industrial groups in the tables below. In official statistics classification* is based on the "establishment" rather than on the "firm" or "undertaking", which may embrace a number of industrially distinct establishments. Consequently, from whatever detail was available about employment in Central Government organizations, in local government, and in other public undertakings, a tentative industrial classification was made. A comparison of the results of this tentative classification with the figures of total employment in each industry suggested that for some industries the estimates of employment in the public sector were reasonable, while for others they were not. The latter were therefore subjected to further research and revised.

11. A summary of the figures thus obtained is given in Table 1, which shows that of the total number of persons engaged in civil employment at the middle of 1950, 22½ per cent. were in the public sector and 77½ per cent. were in the private sector. Of the total working population in employment (i.e., including the Armed Forces and Women's Services), 25 per cent. were in the public sector and 75 per cent. were in the private sector. In terms of employment, about 70 per

TABLE 1

Public and private enterprise in various industry groups as at June, 1950

Industry	000's				
	Manpower at June, 1950	Central Govern- ment	Local Govern- ment	Other Public Undertakings	Private Enter- prise
	%	%	%	%	%
Agriculture and mining	2,103 (100)	35 (1·7)	—	752 (35·7)	1,316 (62·6)
Manufacturing and building	9,899 (100)	121 (1·2)	85 (0·9)	180 (1·8)	9,513 (96·1)
Public utilities (transport, gas, etc.)	2,135 (100)	293 (13·7)	134 (6·3)	1,057 (49·5)	651 (30·5)
Civilian services†	8,217 (100)	688 (8·4)	1,203 (14·6)	481 (5·9)	5,845 (71·1)
Total in civil employment	22,354 (100)	1,137 (5·1)	1,422 (6·4)	2,470 (11·0)	17,325 (77·5)
H.M. Forces and Women's Services‡	690 (100)	690 (100·0)	—	—	—
Total working population in employment	23,044 (100)	1,827 (7·9)	1,422 (6·2)	2,470 (10·7)	17,325 (75·2)

* Standard Industrial Classification, H.M.S.O.

† Distribution, professional, financial and miscellaneous services.

‡ Figures for the Armed Services include those serving overseas.

1951]

cent. of the public utilities (gas, electricity, water and transport) fell in the public sector, while 96 per cent. of manufacturing and building fell in the private sector.

12. The industries which were nationalized or which were set up under public ownership between the middle of 1945 and the middle of 1950 employed at the latter date about 2,464,000 persons. Under pre-1945 conditions, 1,927,000 of these would have been in private enterprise, 418,000 with local authorities and 119,000 with other public undertakings which have been absorbed by the new nationalized bodies created since 1945. The position as it would have been had there been no post-war nationalization programme involving these transfers is shown in Table 2. From this table it will be seen that the public sector falls to 14 per cent. excluding the Armed Forces and Women's Services and 16½ per cent. including them, i.e., between 1945 and 1950 over 8 per cent. of the total working population in employment was transferred from the private sector to the public sector, increasing the size of the latter by almost exactly 50 per cent.

TABLE 2

Public and private enterprise

June, 1950, employment distributed according to the extent of public and private enterprise at June, 1945.

Industry	000's				
	Manpower at June, 1950 %	Central Govern- ment %	Local Govern- ment %	Other Public Undertakings %	Private Enter- prise %
Agriculture and mining	2,103 (100)	35 (1·7)	—	—	2,068 (98·3)
Manufacturing and building	9,899 (100)	121 (1·2)	98 (1·0)	11 (0·1)	9,669 (97·7)
Public utilities (transport, gas, etc.)	2,135 (100)	289 (13·5)	267 (12·5)	111 (5·2)	1,468 (68·8)
Civilian services*	8,217 (100)	675 (8·2)	1,474 (17·9)	21 (0·3)	6,047 (73·6)
Total in civil employment	22,354 (100)	1,120 (5·0)	1,839 (8·2)	143 (0·7)	19,252 (86·1)
H.M. Forces and Women's Services	690 (100)	690 (100·0)	—	—	—
Total working population in employment	23,044 (100)	1,810 (7·9)	1,839 (8·0)	143 (0·6)	19,252 (83·5)

* Distribution, professional, financial and miscellaneous services.

13. The figures in Table 2 include adjustments for certain staffs taken over by the Central Government between 1945 and 1950. Among these are Public Assistance staff and Rating and Valuation staff transferred from local authorities, Health Insurance staff transferred from Approved Societies, and staff transferred from Cable and Wireless Ltd. A number of other transfers have also taken place during the period. In 1948 sub-postmasters and sub-postmistresses were excluded from the Central Government figures as not being, strictly speaking, employees of the Post Office. In the same year the National Fire Service became the local government fire services. Under the Agriculture Act, 1947, the County Agricultural Executive Committees' non-industrial staff were given the status of temporary civil servants, bringing the whole of the manpower involved—industrial and non-industrial—into the Central Government sector for the purposes of this note. These latter transfers have been regarded as mere administrative rearrangements, and have not been allowed for in Table 2.

14. When the present nationalization programme is completed part of the iron and steel industry will be transferred to the public sector, and the British Transport Commission will have concluded its programme of requisitioning road transport undertakings. The former transfer may involve about a quarter of a million workers, and the two together can be estimated to involve perhaps 300,000. This would bring persons engaged in employment in the public sector from just under 25 per cent. to just over 26 per cent. of the total working population in employment. Excluding the Armed Forces, the proportion engaged in civil employment in the public sector would rise from 22½ per cent. to 24 per cent. In spite of the relatively large size of the portion

of the steel industry to be transferred, over 93 per cent. of workers in the manufacturing and building industries will remain under private enterprise. On the other hand, with the transfer of additional road undertakings, nearly three-quarters of the public utilities will be in the public sector.

15. Before concluding this section on employment in public and private enterprise in Great Britain, it would be interesting to attempt some analysis of the figures for private enterprise. Three forms of public enterprise have been distinguished and given separate treatment, and there is certainly no overwhelming homogeneity among the enterprises in the private sector that removes all possibility of logical subdivision. The absence of adequate statistical material, however, prevents any ambitious scheme of analysis being undertaken for the latter, and Table 3 is restricted to showing an approximate division between employers and people working on their own account on the one hand and employees on the other, together with an indication of the number of the latter working for co-operative societies in Great Britain.

TABLE 3
Employers and employees in the private sector June, 1950

Industry	000's				
	Total Manpower	Private Enterprise			Employees of Co-operative Societies* (included in previous column)
		Total	Employers and Self- Employed	Employees	
Agriculture and mining	2,103	1,316	325	991	11
Manufacturing and building	9,899	9,513	430	9,083	92
Public utilities (transport, gas, etc.)	2,135	651	50	601	1
Civilian services	8,217	5,845	995	4,850	280
Civilian employment	22,354 (100%)	17,325 (77.5%)	1,800 (8.1%)	15,525 (69.4%)	384 (1.7%)
H.M. Forces and Women's Services	690	—	—	—	—
Working population in employment	23,044 (100%)	17,325 (75.2%)	1,800 (7.8%)	15,525 (67.4%)	384 (1.7%)

* Average number of employees in the year 1949, excluding employees on tea estates overseas.

16. The co-operative societies referred to are those societies registered under the Industrial and Provident Societies Acts that operate on a co-operative basis, including retail, wholesale and productive societies as well as those engaged in banking, insurance, miscellaneous services, laundry work, land and housing business and trading societies in agriculture and fishing. The latest figures available, unfortunately, refer to the average numbers employed during the year 1949; the figures for 1950 will probably be greater, but unless they rise somewhat above 400,000 they will still represent 1.7 per cent. of the total working population in employment.

(Since the above was written, the total manpower and employment figures for Great Britain used in this Section have been revised by the Ministry of Labour and National Service in the light of information derived from the count of National Insurance Cards in June, 1950.)

III

The Extent of the Public Sector of the United Kingdom in Terms of Gross National Product

17. It is possible, by using the financial data now available for the calendar year 1948, or for the accounting year most closely coinciding with it, to estimate the proportion of the gross national product which can be attributed to activity in the public sector as at present constituted (1950). It is not possible, however, to make a satisfactory estimate of the proportion for the public sector as constituted in 1945.

18. The "product" figures taken for the individual organizations and undertakings were the

1951]

figures of net outputs including depreciation. Where possible they were built up from the profits (before payment of interest or direct taxes), depreciation, wages and salaries shown in annual accounts and balance-sheets. In some cases the preliminary results of the Census of Production, 1948, were used, either as a check on the figures built up from the accounts, or as an alternative method of assessing net output where accounts were not available. In these cases net outputs as measured by the Census had to be reduced to allow for the inputs of services performed by other undertakings, since these are included in "net output" as defined by the Census. Figures for the Hospital Boards were estimated on the basis of data appearing in the Civil Estimates, 1948/1949 and 1949/1950. In some of the smaller undertakings, figures relating to employment and average earnings were the only material available on which estimates of net output could be based. Net output for the British Transport Commission includes an estimated allowance for road transport undertakings acquired since 1948.

19. The datum for the Armed Forces and Women's Services was obtained from "National Income and Expenditure of the United Kingdom, 1946 to 1949"*; the figure relates purely to the pay and allowances given in 1948. The figure for the civilian sector of the Central Government was built up as follows:

	£ millions
Wages and salaries in the United Kingdom (industrial and non-industrial civil service, Civil List, Members of Parliament and persons paid out of the Consolidated Fund, etc.)	408 (partly estimated)
Depreciation:	
Non-trading (Cmd. 7933)	9
Trading (Post Office)	18
Income from property (Cmd. 7933)	56
	491
Net output of other organizations (Cable and Wireless, N.A.A.F.I., and part of County Agricultural Executive Committees)	23
Central Government organisations, civilian sector	514

20. The local government figure was built up as follows:

	£ millions
Wages and salaries in the United Kingdom (trading and non-trading activities)	451 (partly estimated)
Depreciation: trading and non-trading (Cmd. 7933)	119
Trading profits (Cmd. 7933)	14
	584
Net output of other organizations	9
Local Government activities	593

21. It was impossible to make any industrial analysis of output which would have given a reasonably accurate statement of the facts for even the broadest of industrial groupings. The figures for the various organizations and undertakings were therefore summarized and the results are given in Table 4, the total for the private sector being a residual item as it was in the calculation based on manpower.

* Cmd. 7933, H.M.S.O.

TABLE 4

*Gross output in public and private enterprise (in terms of 1948 earnings),
United Kingdom*

	£ millions	Percentage of Gross Output
Central Government organizations:		
Civilian sector	514	4.8
H.M. Forces and Women's Services	246	2.3
	760	7.1
Local government activities	593	5.5
Other public undertakings	1,097	10.3
	2,450	22.9
Total public sector	8,253	77.1
Total private sector		
Gross national product of the United Kingdom (Cmd. 7933)	10,703	100.0

22. It will be seen from Table 4 that the Central Government's activities contribute 7.1 per cent. (of which the Armed Forces and Women's Services are responsible for 2.3 per cent.), the local authorities contribute 5.5 per cent., and other public undertakings contribute 10.3 per cent. to the gross national product, aggregating 22.9 per cent. for the public sector in the United Kingdom. These figures are all slightly below those established by the man-power criterion for Great Britain, which gave 7.9 per cent. for the Central Government, 6.2 per cent. for local authorities and 10.7 per cent. for other public undertakings, aggregating 24.8 per cent. at mid-1950.

23. It would not be correct to infer from this result that output per man in the public sector was necessarily less than it was in the private sector. In the first place, output in parts of the public sector is not measured or measurable in the same terms as it is in the private sector; the full rental value of public buildings is understated in the total of schedule A tax assessments, while no money profit arises out of many communal services financed out of taxation, and no revenue is available to cover depreciation of the assets employed in them. In the second place, there are the differences in geographical coverage and in timing between the manpower and the output figures. Finally, a generous allowance must be made in both sets of figures for the margins of error which are the unwelcome concomitants of calculations of this nature.

24. A certain amount of information relating to the accounts of societies registered under the Industrial and Provident Societies Acts and the Industrial and Provident Societies (Northern Ireland) Acts is available for the year 1948. From this information it is possible to make a rough estimate of the net output of co-operative societies in the United Kingdom. The figure used for profits is defined as the total of surpluses accruing in the year 1948 before the payment of interest on shares, dividends on sales, bonuses to employees, grants for educational and charitable purposes and direct taxes. The figure for depreciation was obtained from a sample investigation.

	millions
Wages, salaries and commission	95
Profits	62
Depreciation	8
	165

25. Co-operative societies therefore account for between 1.5 per cent. and 1.6 per cent. of the gross national product of the United Kingdom. The percentage of the total working population in employment in Great Britain working for co-operative societies was estimated at 1.7 (see Table 3).

26. Information and assistance from the statistical departments of the Ministry of Labour and National Service, the Registrar of Friendly Societies and the Ministry of Fuel and Power are

1951]

gratefully acknowledged. The responsibility for the use made of the advice and information received, however, rests solely with the author.

APPENDIX

Undertakings in the Public Sector

Great Britain

Central Government Organizations:

- Royal Households.
- Houses of Parliament.
- Courts of Justice.
- College of Arms.
- Duchies of Cornwall and Lancaster.
- Civil Service Establishments (industrial and non-industrial) including Cable and Wireless Ltd. (socialized part).
- Armed Forces and Women's Services.
- Navy, Army and Air Force Institutes.
- County Agricultural Executive Committees (part not in Civil Service).

Local Government Activities:

- Local authorities (trading and non-trading) activities including police, fire service, education, etc.
- Water Boards.
- New Town Development Corporations.

Other Public Undertakings:

Nationalized Corporations:

- British Broadcasting Corporation.
- North of Scotland Hydro-Electric Board.
- Bank of England.
- Airways Corporations (absorbing B.O.A.C.).
- National Coal Board.
- Raw Cotton Commission.
- British Transport Commission (absorbing L.P.T.B.).
- *British Electricity Authority and Area Electricity Boards (absorbing C.E.B.).
- *Hospital Boards.
- *Gas Council and Area Gas Boards.

Other Public Authorities and Services:

- British Council.
- National Service Hostels Corporation, Ltd.
- Remploy, Ltd.
- National Dock Labour Board (administration only).

Northern Ireland

Central Government.

Local Government.

Other Public Undertakings:

- Ulster Transport Authority.
- Northern Ireland Electricity Board.

* Formerly partly under local authorities and partly under private enterprise.

HISTORICAL SURVEY OF THE DEVELOPMENT OF SAMPLING THEORIES AND PRACTICE*

By YOU POH SENG

THE use of sampling in statistical surveys is a relatively modern development. Before the end of the last century sampling had been rarely employed, and even then not in a completely scientific manner. Chiefly owing to the fact that the statisticians responsible for the employment of the method never gave an account of how they took the samples, of what difficulties they encountered, or of what steps they took to counter these difficulties, and did not discuss the accuracy of their results, it is impossible for us to decide whether properly to call them sampling surveys, and how to evaluate their experience. Thus, in 1861, Dr. William Farr used a partial sample for the collection of statistical data in the English Census of population: all he mentioned of the procedure was that he took 14 "sub-districts" with a total population of 264,327, and examined the number of families and persons in relation to houses, special emphasis being laid on family composition (Census, 1861). In the same report we find detailed observations in ten chosen counties on the number of landlords distributed according to number of employees and size of farms. All we can assume is that the samples were taken randomly, and certainly if he used any controls he did not mention them.

It is also interesting to note that the so-called sample investigations were usually taken in conjunction with a census. No sample survey as a separate investigation had ever been undertaken. But owing to reticence concerning the sample design, sampling could not really be regarded as systematically developed.

It was not until A. N. Kiaer took office as Director of the Bureau of Statistics in Oslo (then Kristiania) that the practice, and to a lesser extent the theory, of sampling began to be systematically developed: not until he took the platform at the International Institute of Statistics in 1895 was sampling method in statistical investigations first introduced to and debated by an international body of statisticians.

The work of Kiaer can be regarded as a turning-point in the history of Statistics. Born in 1838, he was made head of the Norwegian Bureau of Statistics when it became an independent body for the collection and interpretation of social and demographic facts. As head of the Bureau of Statistics, he was responsible for the decennial censuses of population and agriculture during the last quarter of the century, the measurement of movement of population, and many other official investigations.

He was the first to use the sampling method in collecting data independently of the census. He systematically built up the case for using this method, and carried out several purely sampling investigations for the Bureau of which he was head.

The main part of his work on the use of the method in the collection of official statistics appeared in various publications of the International Institute of Statistics (Kiaer 1895, 1899, 1901). Here he brought the method to the serious attention and discussion of other statisticians.

In the session of the Institute in Berne in 1895 he attempted to clarify the meaning of "dénombrements représentatifs" (representative investigations). He stressed that by "dénombrements" he did not mean a census or any ordinary enumeration, nor did he intend that it could take the place of a census; it was used to signify a special type of enumeration aimed at collecting detailed information which could not be obtained in a census.

Thus he intended to introduce a word to express neither a haphazard enumeration nor a full inquiry but rather an investigation based on information collected from individuals who had been first selected according to a particular representative method.

Modern usage can express this more clearly. What he was in search of was a "sampling

* This article is based on the first chapter of the author's Ph.D. thesis "Techniques of Sampling", presented in May, 1949.

investigation" based on information collected from sampling units which have been first selected according to a sampling design.

We shall have occasion later on to elaborate on his meaning with regard to his definition of "dénombrement représentatif". Meanwhile it is of interest to follow him in the detailed description of his use of the method in two particular surveys carried out under his direction in Norway.

The first was an investigation carried out in 1894 throughout Norway on a proposed retirement pension and sickness insurance scheme. The most notable point was that, while the decennial census did not, and could not, give the details required for the purpose of this investigation, he had no need to carry out a full survey corresponding to a census to collect these details. Here, in fact, is an instance of the vast potentiality of sampling survey, and of its advantage for an independent survey of conditions touching very closely on the social and economic life of a large proportion of the population.

There were over 60 questions asked in this survey, which was to be made by special investigators. They were to interview more than 120,000 adults, of whom 80,000 were to constitute the investigation proper, and 40,000 a parallel investigation to be made in localities inhabited by the working classes.

For the investigation proper, the total number of interviews were allocated proportionately between the towns and country districts, the proportions being determined by the Population Census taken in 1891, so that about 20,000 persons were interviewed in the towns and 60,000 in the country districts.

The method of selection of the sampling units in the town areas differed from that in the country districts.

Towns.—Thirteen towns were chosen, including all the five large towns with populations of 20,000 or over. As there were 61 towns in Norway at that time, this meant that about one-fifth of them were investigated. The number of interviews were not distributed among the larger and smaller towns in proportion to the total population of each. Since the total population of all the smaller towns is relatively greater than that of the larger towns, it follows that more interviews should be allocated to the smaller towns chosen. So that, while Kristiania had to return 6,350 schedules (or an equivalent of one-sixteenth of its adult population in 1891), some other towns chosen had to return a total number of schedules corresponding to about one-ninth of their adult population, and some a third. Kiaer claimed that this method of distribution of interviews was not only rational, but also advantageous in that the final results could be derived more readily.

In Kristiania, where there was an annual enumeration of the population, information in this respect was rather detailed and therefore useful. Thus in 1892, according to the enumeration taken that year, there were 400 streets in the town divided into four categories, viz.:

- (a) 100 streets each with population 100 or over;
- (b) 187 streets with 101–500;
- (c) 80 streets with 501–1,000; and
- (d) 33 streets with 1,001 and over.

The interviews were to be undertaken as follows:

- (a) The entire population of one-twentieth of the least populated streets.
- (b) One-tenth of the streets of the second category, but only half the houses in each to be enumerated.
- (c) One-quarter of the streets of the third category, one-fifth of the houses in each to be enumerated.
- (d) One-half of the streets of the fourth category, one-tenth of the houses in each.

In the selection for enumeration care was taken to ensure an even spread throughout the town.

The same procedure was to be adopted in the other large towns and the medium towns, while in the small towns only the adult population of three or four houses were interviewed. It is to be mentioned that Kiaer did not go into the details of the sampling procedure in these towns, but it should be clear that the general procedure was the same.

Country districts.—A different procedure was adopted in the sampling in country districts. The interviews were to be distributed among the 18 rural prefectures in Norway according to

their rural population in 1891. To obtain as correct representation as possible, the communes in each prefecture were classified according to predominantly agricultural, stock-farming, forestry, industrial, shipbuilding, and fishing. A number of representative communes were chosen from each category. The interviews in each prefecture were distributed so that the total selected for examination in each category of commune was proportional to the total population for that category in the entire prefecture.

The total number of communes represented was 109, an average of 6 per prefecture, while the total number of communes in the whole country was 498 in 1891.

In each category in each prefecture, however, the number of interviews allocated to each chosen commune was not proportional to its population, owing to the fact that some communes chosen represented, by virtue of their principal occupations, a population too large or too small compared to the total communes in the category; e.g. certain communes, while representative geographically, were, owing to the nature of their special industries, too predominant in their representation of those particular industries. This difficulty was overcome by distributing to these communes a relatively smaller number of interviews than to others, and *vice versa*. Thus in some prefectures there were some communes with half their adult population enumerated, some with one-third, some with one-sixth, and some with even less.

In the chosen communes themselves an effort was made to distribute, as far as possible, the interviews among the different parishes of the communes proportionately to their populations, distinguishing those with sparse and those with dense populations. Distribution in each subdivision of each commune was left to the discretion of enumerators, who were instructed to choose the routes of investigation to conform with the purpose of representativeness of the study, care being taken to enumerate not only socially "average" houses, but also in general houses representing different social and economic conditions in the commune.

A special precaution was introduced in the study. To guard against possible imperfect representation, a certain number of interviews were reserved for each prefecture for correction of differences or errors. For this purpose, for each prefecture the number of interviews that should have been returned for each occupation was calculated according to the census of 1891. These were then compared with the numbers actually returned, and adjustments were made by supplementary reports to make up for the gaps in the two figures, or, where the numbers actually returned were larger than those expected, the excess was eliminated. If the difference were not too large, it could be ignored, partly because it could be compensated for in the sum total for the whole prefecture, and partly because it is neither possible nor necessary that a representative investigation should correspond to a full census in all its details.

The second survey described by Kiaer in the same report was mentioned to show that a representative investigation could be made in more ways than one. This survey had for its purpose the ascertainment of distribution of incomes of adult males in Norway by occupations, ages, and civil status.

For this survey, 23 representative towns and 127 representative rural communes were chosen. In each chosen area the individual returns in the General Census of 1891 for males aged 17, 22, 27, 32, 37, . . . , up to 97 were extracted from all the returns, so that only one-fifth of the adult males for each representative town or commune were included in the survey. To reduce still further the resulting large number of returns, only those returns of persons whose names began with the letters A, B, C, L, M and N were used (for Kristiania and other populated towns, only persons whose names began with L, M and N were included). To the information given on the returns for these selected persons were added details regarding their incomes collected in a special interview-survey. This survey comprised an average of only about 3.3 per cent. of the male population of Norway living in country districts and 1.6 per cent. of that living in towns (or a total number of only about 10,800 individuals).

Comparisons of census and survey results regarding distribution by professions (or occupations) showed favourable representation, the only large difference, that for the marine population, being explained by the fact that the census figures applied to the "actual" population, while the survey figures applied to the population "de droit", which in Norway comprised a large number of foreign sailors.

Apart from all his other achievements, his clear presentation of a method of drawing the "representative" samples was sufficient to win for Kiaer a place among the pioneers of sampling

1951]

investigations. Of course, there was considerable vagueness in the presentation of his technique, and he did not analyse his survey results as we, in the present state of our knowledge, would do. He did, however, by his persistent efforts, bring about the adoption by the Institute of a recommendation urging the specification of the conditions under which the selection of observation units is made. To this we shall return.

By scientific insight Kiaer realized that the more or less recognized method of completely random selection is not the only, nor even the best, method of drawing a sample. Thus, in the discussion following the presentation of his report, he maintained that the conditions of a country could be thoroughly studied by taking a large enough number of small geographic units or localities spread over the country. These units could serve to "represent" the country if the selection of the units had been carried out *rationally*. Here we notice two very important conditions of a successful sampling investigation: proper representation and rational selection of units.

The method he used for proper representation is, to us, a well-worked-out method of stratification, the stratification factors being geographic, social and economic. In the first of the two investigations mentioned above, geographic stratification was achieved by the division of the universe into town areas and country districts, and by further subdivision of these. For stratification according to social conditions he used, in the towns, the division into the four categories of streets, it being assumed that the least populous streets represent the wealthier stratum of the town and the most populous streets the poorer stratum, while the intermediate streets would therefore represent average or medium social and economic conditions.

In the country districts the stratification used was according to main occupations, and further, definite instructions were issued to interviewers to select, not only socially "average" houses for investigation, but also houses representing different social and economic conditions. Of course, bias due to human choice was inevitable, but at least the method of stratification was clear. Further, Kiaer introduced proportional selection in each chosen stratum based on the population details of the previous census.

The complete theory of stratification was not developed until the time of Neyman, but even so, Kiaer, by sheer common sense, had already adumbrated a method of stratification which even today would be a useful model for developing a sampling design requiring multiple factor stratification.

To summarize the method, we can do no better than to quote Kiaer: "It is fundamental to observe that the accuracy of the results of a survey depends, not on the larger or smaller number of observations made, but on the method of obtaining correct representation". And this is fundamental indeed. Certainly before Kiaer's work there was a tendency to distrust any sample survey which included only a small fraction of the universe. Nor, even to-day, is this tendency moribund. Kiaer showed that this was no valid criticism, provided the method of selecting sampling units ensured correct representation. Later developments provided the justification for his viewpoint.

In the general discussion at the same session of the Institute there was strong opposition to the representative method of investigation. Professor G. von Mayr (of Munich University), L. Bodio, the secretary-general of the Institute and President of the Supreme Council of Statistics of Italy, and G. E. Milliet were opposed to the method, all their arguments depending on the alleged sanctity of the census method.

On the other hand, Cheysson pleaded that there should be no prejudice against the new method, which, however, he wrongly designated monography. Levasseur, the Vice-President of the Institute, stressed that it was necessary to deal with three distinct cases: general statistics, which was statistics properly speaking and concerned itself with the totality of phenomena of the same order throughout one region, one state or province; monography, which was concerned with detailed description of an object or phenomenon, or of some aspects of particular units of the universe; and finally, statistical explorations. The first two were complementary to each other; but there should be room for the third, which dealt with the study of conditions by means of statistics not of the totality of phenomena, but of a determinate and restricted part of the phenomena. Schmoller was of the opinion that the method was useful where the materials for investigation were complex or more numerous than could be handled by a general statistical investigation.

Summing up the case for the opposition, Mayr stated that, though there were a large number

of social facts which could not be enumerated, or measured, or weighed, but could be studied by monography, the "representative" investigations of Kiaer were not concerned with such facts. Rather they were concerned with issues where measurements or counts of the whole could be made, but where only parts of this whole were deliberately ("de propos délibéré") drawn and studied. While he agreed with Levasseur that these studies had their value as "investigations on a fixed point", that is, that they had their special value, he maintained that it was not correct to regard the results of such investigations as giving sufficient information in default of a complete inquiry of the whole. Such a complete inquiry, he insisted, could never be replaced by a partial "representative" investigation.

In view of such opposition, it is interesting to follow up Kiaer's defence of the method in the next session held four years later in St. Petersburg. His long discourse in this second session is of importance also for his clear distinction between representative and typological investigations.

Kiaer's definition of representative investigation was that it was a partial inquiry in which observation was made on a large number of units distributed throughout a country or territory so that their totality would form a miniature of the whole country or territory. These units were not chosen arbitrarily, but according to a rational scheme based on the general results of some previous statistical investigations. The distribution of the observations was so arranged that the results could be controlled in many respects by these general statistics. As to investigations by "types" (i.e. average cases), while these were useful, they would seem to abound with disadvantages compared with representative investigations. Thus, even if one knew the proportions which the individuals represented by the types made of the whole field of inquiry, the types were far from giving plausible results for the totality, for the totality comprised not only the types, but also a variety of extreme and non-typical cases found in reality. It was therefore necessary, in order that the investigation should present a true miniature of the whole, to observe not only the "types", but also all kinds of phenomena. This was the kind of investigation which could be made, if not exactly, at least approximately, by the representative method which neglected neither the "types" nor the variations from the "types".

To the objection that representative investigations had only a special value relative to the parts observed and that they could not therefore be interpreted for the whole, he replied that this was applicable only to investigations which were not representative. In so far as these investigations were representative, they constituted in the totality of observed units a "photograph which reproduces the details of the original in its true relative proportions".

He admitted that he could not understand the logic of the argument that the monographic method was concerned with objects which could not be counted, or weighed, or measured, while statistics was concerned with objects which could in their totality, but which "de propos délibéré", were only counted, or weighed, or measured in parts. This argument would seem to confine the use of monographs to descriptions or other non-numerical matters, while numerical matters should be reserved exclusively for the field of general statistics. Such an argument showed ignorance of the work of many statisticians who had applied numerical measurements in monographic studies—for example, the work of Theysson on the comparative budgets of ten monographs or types of families. Once it was admitted that it was necessary in certain cases to use partial investigations, it was surely desirable to improve those investigations by precise counting, weighing and measurement.

But those opposing it either could not accept this argument, or did not desire to do so. The dissension had at least revealed the area of agreement and disagreement. All agreed that a partial investigation could never have the same value as a complete inquiry, and that there were some cases where a partial investigation was inappropriate even if it was not possible to make a complete inquiry. They differed on Kiaer's assertion that there were many cases where complete statistics were impossible to obtain, but where partial investigations could be used to advantage. For this it was sufficient to refer to the numerous publications of the Departments of Labour in America and many European countries recounting many partial investigations. One could apply to representative investigations the words which Bodio pronounced in the session at Berne, in connection with the work of Engel on budgets of working families: "Monography and enumeration are two ways of investigating social facts which are complementary to each other. The latter, by itself, gives only the general profiles of the phenomena, the silhouette, so to speak, of the figures. Monography (and Kiaer added, partial investigations in general) permits us to

1951]

push our analysis into all the details of the economic and moral life of the people: it supplies blood, flesh and nerves to the skeleton built up by general statistics. Enumeration in turn completes the results obtained by monography". Here we have a lucid statement of the reciprocal relationship between general statistics and partial investigations in general.

According to Kiaer, it was important to stress that the scientific value of partial investigations depended more on the representative character than on the number of the observations. There were, he asserted, numerous ways of obtaining representativeness. If comparisons showed conformity between the results of the partial investigations and those of the general census, valid conclusions could be derived, it being assumed that to the extent that any partial investigation could be shown to be correct in the controlled factors, it was probably correct also in the factors which could not be controlled.

Kiaer pointed out that the results of a partial investigation could be controlled to a certain extent even in default of general statistics. Leaving aside regularity of phenomena, which was itself a control, the results of a partial investigation could be controlled by making use of the results of other partial investigations obtained by different representative schemes, and it was clear that if we could obtain the same (or approximately the same) results by various methods, greater faith could be placed on these results.

Such was the force of the arguments put forth by Kiaer in favour of representative investigations that, although the Institute was not prepared to recommend the use of the method, it felt compelled to nominate a sub-committee to discuss more fully every aspect of the problem. It was arranged that this sub-committee should report at the next session.

In the same year in an article in the *Allgemeines Statistisches Archiv* Kiaer reiterated the case he had stated at the Institute, and outlined the representative investigations carried out under his aegis in Norway. One can summarize the salient points of this article:

(i) The representative method of investigation is applicable not only in the field of social and economic inquiries, but also in that of agriculture and forestry.

(ii) To obtain an exact representative selection it is necessary to group the different communities under investigation. Thus in social inquiries, the towns and country communes are differentiated, and are further divided into large, medium, small, coastal, inland, industrial and rural. This principle of grouping (or stratifying) homogeneous parts of a country must be applied with care to obtain a really representative sample.

(iii) The questions propounded should as far as possible follow the lines of the general census, so that the results can be controlled, and so that the statistics can be thoroughly analysed.

(iv) If possible two or more different systems of obtaining a representative sample should be used so that greater faith can be placed on the results of the inquiry, and proof of the usefulness of the method can be obtained.

(v) It is important to study and develop the practical and theoretical aspects of the method, so that proper limits can be set to representative statistics.

In the following session of the Institute in Budapest, in 1901, Kiaer was especially eloquent in his plea for the representative method of investigations. He reiterated that a detailed investigation of a town, or of a certain quarter of a town, could hardly be called a representative investigation. If the town, or quarter of the town, could be regarded as a type, then we had a typological investigation; but one could not generalize those results. If, however, one were to gather the information from a number of units distributed at random, so that in some parts of the universe one observed a large number, and in others a small number of units, one would have partial investigation, not generally representative. To attain representativeness one should have a large number of units distributed so that localities of different characteristics are represented in the same proportion as in the universe.

For practical proofs of the representative character of the method, Kiaer could cite numerous experiments he had carried out in Norway which showed that certain statistical phenomena required more numerous and more carefully selected observations than did others. Thus population growth and migration statistics could not be investigated by the representative method as easily as the relative figures concerning births and deaths.

Where an investigation dealt with matters which had not previously been investigated, or

which could not be controlled by comparison with the census, Kiaer suggested the division of the investigation into two or three distinct parts, using for each a different representative method of selection. If these several parts gave similar results, accurate representativeness could be guaranteed.

To conclude, Kiaer re-affirmed his opinion that the representative method could be recommended in many investigations as being preferable to partial investigations made at random and without regard to the rule that results collected for the different parts should be distributed proportionately.

The discussion following Kiaer's general report was of particular importance. There was, of course, the general objection that the method was beset with difficulties and could be dangerous to apply, particularly where the population studied contained dynamic characteristics caused, for example, by migrations between countries, or between provinces within countries.

A very interesting contribution was made by Bortkiewicz on the "Method of Controls". His view was that, while the method constituted a most important advance, the form in which it was presented by Kiaer was subject to a grave objection, largely because of what Bortkiewicz called the "coincidence of approximation". If, for instance, one found 1.8 per cent. of one's partial observations belonged to a certain profession, and actually 2 per cent. was found for the universe, one would declare oneself satisfied with the results of the investigation. But, in so far as these two were not strictly equal (and never could be), our conclusion was to that extent subjective. The one way to overcome this difficulty would be to appeal to the Calculus of Probability, to determine if the difference between the two figures (0.2 per cent. in our example) could or could not in fact spring from chance; and the probability could be calculated according to Poisson's Formulae. If the difference was larger than could be regarded as fortuitous, we should have to conclude that our investigation was not representative of the whole. According to this criterion, Bortkiewicz had put Kiaer's results as presented in the *Allgemeines Statistisches Archiv* to the test, and had found them to be generally not satisfactory.

Bortkiewicz thus interjected into Kiaer's argument a more scientific test of representativeness. Bortkiewicz did not formulate the tests to be applied in a stratified sample, but the fact remained that he did bring the possibility of the application of such an objective test to the notice of statisticians in general. Although he was not the first statistician to employ this method in connection with sampling, he was the first to express the basic idea.

In the ensuing session of the Institute in Berlin, in 1903, Kiaer's purpose was fulfilled. In this session the Sub-Committee which had previously been appointed by the Institute to study the representative method proposed the following resolution:

"The Committee, considering that the correct application of the representative method, in a certain number of cases, can furnish exact and detailed observations from which the results can be generalized, within certain limits, recommends its use, provided that in the publication of the results the conditions under which the selection of the observation units is made are completely specified. The question will be kept on the agenda, so that a report may be presented in the next session on the application of the method in practice and on the value of the results arrived at".

Thus sampling, in whose genesis Kiaer had played such a predominant role, received the official imprimatur of the world's statisticians. Every outstanding figure in the further development of sampling has concentrated on some particular aspects of the theory: Kiaer was the first, and to date the last, to take a catholic view of the field.

It is true that Kiaer discussed the method of random sampling; it is true that his own method of selection was akin to what was later called the stratification method; but the basis of his method was more intuitive than scientific. Enlightened intuition preceded scientific validation. Kiaer showed the possibilities of the sampling method independent of and complementary to the census. He cleared the ground for others to cultivate. The crops that have so far come to fruition represent the particular interests of his successors; the varieties that remain to be evolved are limitless.

Kiaer had shown, and the International Institute of Statistics had recommended, that sampling could be used to advantage in the study of social and economic problems. A critical evaluation

1951]

of the results of the sample techniques was the next step in the development. If, following Kiaer, one admits the Method of Controls, then Bortkiewicz's caveat becomes relevant; what confidence can one place on the representative character of the sample if, for the controlled factors, there is a difference between the constant calculated from the partial observations and the constant expected from the general statistics used as the basis for control? And thus, what confidence can one place on the analyses of the sample observations? Next, how can one estimate the population constants from the results of the samples? And what confidence should be placed on these estimates? An understanding of, and an improvement in, the techniques of sampling were clearly necessary.

This was Professor Bowley's task and his achievement. Bortkiewicz, as we noted, had raised the first problem but did not adumbrate a reasoned solution to it. However, he did suggest the line of attack upon it. It was not until 1906 that Bowley, in his Presidential address to the Economic Science and Statistics Section of the British Association for the Advancement of Science, presented the problem in its crystallized form and suggested a systematic solution. Owing largely to the work of Professors Karl Pearson and Edgeworth, statistical theory had developed extensively during the last quarter of the nineteenth century, but its application to practical statistics had been scant. As Bowley wrote: "In recent years progress . . . of theory has, indeed, been rapid, and a great number of important and thoroughly criticized methods are ready for use, and are, in fact, in constant use by biologists and botanists; but there has been remarkably little application to practical statistical problems. In the thirty years following the publication of Quetelet's *Lettres*, attention was mainly given to establishing the constancy of great numbers and averages based thereon, an important but limited work, while the relation of the frequency of deviations to the law of error was regarded rather as a statistical curiosity. Professor Edgeworth's illustrations in 1885 of the importance of mathematical methods in testing the truth of practical deductions have as yet borne singularly little fruit . . . it is time that it [mathematical statistics] was brought to bear on the criticism and analysis of existing industrial statistics . . . most of our statistics remain untested and their significance not analysed. The simple method of samples, . . . , for which all the materials have existed for at least twenty years, has (so far as I know) been completely ignored" (Bowley 1906).

Bowley's proposal to make use of the theory of probability was of great significance; it instituted a new epoch in the theory of sampling, supplementing Kiaer's original work.

To quote Bowley again: "The region to which I am devoting particular attention is that where the theory of probability is involved, not because there are not many other directions in which mathematical methods are useful, but because this is of the greatest importance and the least generally understood. All depends on a complete grasp of the nature of the measurement when we say, for example, that from certain data the most probable estimate of average wages is 24s.; it is as likely as not, however, to be as much as 4d. from this value: the standard deviation is 6d.; the chances are 10 to 1 against the average being over 24s. 8d., 100,000 to 1 against it being over 26s. This is the kind of statement to which calculations lead. The result may be briefly indicated as 24s. \pm 6d., when the 'standard deviation' is adopted as the measure of accuracy. In a normal curve of frequency about two-thirds of the area is within the standard deviation: the chance that a given observation should be within this distance of the true average is 2:1. The unit of measurement thus devised is most subtle and most complex. When it is applicable it gives the only complete measure of precision. When the initial difficulty of appreciating the nature of mathematical probability is overcome, a difficulty which rather grows than diminishes as one works at it, there still remains the greater task of deciding in what cases it can properly be applied and on the method of calculation. It has, in my opinion, often been used where it is not appropriate, where the chances of deviation are not those indicated by a normal curve . . . Thus it has sometimes been argued that if pn cases of a particular kind are found in n instances, then (without further analysis of the relation of the cases to the whole group) the 'statistical coefficient' for the class is $p \pm \sqrt{\frac{p(1-p)}{n}}$, a deduction not based on sound theory; if in fact (here I follow Lexis) the deviation found from this formula is compared with that actually found from several observed values of p , the two do not in general coincide. In general, two lines of analysis are possible: we may find an empirical formula (with Professor Karl Pearson) which fits this class of observations, and by evaluating the constants determine an appropriate curve of frequency,

and hence allot the chances of possible differences between our observation and the unknown true value; or we may accept Professor Edgeworth's analysis of the causes which would produce his generalized law of great numbers, and determine *a priori* or by experiment whether this universal law may be expected or is to be found in the case in question".

His solution of the problem followed the analysis of Edgeworth, based on the "Central Limit Theorem". Thus: "If quantities are distributed according to almost any curve of frequency, satisfying simple and common conditions, the average of successive groups of, say, 10, 20, 100, . . . , n of these conform to a normal curve (the more and more closely as n is increased) whose standard deviation diminishes in inverse ratio to the number in each sample. . . . Take, first, a number of small samples (say, 4 or of 10 in each) and observe the curve of frequency for these; if there is a reasonable indication of the shape of the normal curve appearing, I calculate the 'standard deviation' for this grouping, say σ , and proceed with confidence to deduce that the average of a much larger, say, of n , will have a normal curve of frequency, with deviation nearly $\sigma \cdot \sqrt{\frac{10}{n}}$, where 10 was the number in the first group of samples. If we can apply this method . . . , we are able to give not only a numerical average, but a reasoned estimate for the real physical quantity of which the average is a local or temporary instance".

Here, then, is the foundation of the theory which not only supplies a justification of the sampling method, but also enables us to estimate the true value of our statistical constants. Also it indicates to what degree of confidence we can accept these estimates. It need not be stressed that the theory as evolved by Bowley is applicable solely to random samples. ". . . the chances are the same for all the items of the groups to be sampled, and that the way they are taken is absolutely independent of their magnitude".

As we shall see, different sampling types require modification to this theory as applied to the random sampling type. The theory of probability was not new, but in its application to sampling statistics Bowley attained his pre-eminent position, as he says: "The method of sampling is, of course, only one of many instances of the application of the theory of probability to statistics . . . when it is used the test of precision is ignored. We are thus throwing aside a very powerful weapon of research. It is frequently impossible to cover a whole area, as the census does, or as Rowntree here [York, where the address was delivered] and Mr. Booth in London successfully accomplished, but it is not necessary. We can obtain as good results as we please by sampling, and very often quite small samples are enough; the only difficulty is to ensure that every person or thing has the same chance of inclusion in the investigation".

We notice that while, only a few years previously, Kiaer had to use all the eloquence at his command to plead for the use of the sampling method, Bowley, by his new "powerful weapon of research", could boldly declare that a full census or inquiry was not necessary, and further, that often small samples sufficed for the survey. He had the authority of a theoretician applying himself to the practice of sampling statistics; Kiaer had only his own intuition and courage, with no theoretical support.

In the ensuing twenty years Bowley and those he gathered around him completed a series of sampling surveys into the social and economic conditions of many towns of England. He contributed significantly to the "New Survey of London Life and Labour", and at the same time developed the theory of sampling in his monograph, "The Measurement of The Precision attained in Sampling" (Bowley, 1926).

Meanwhile, the International Institute of Statistics, after a lapse of nearly two decades, returned to the problem with new vigour. At the conclusion of the discussion at its Berlin session in 1903 it recommended that the representative method be used, subject to the reservation which we have noted above, and further suggested that a report be drawn up in the following session on the application of the method. Such a report was not compiled in its next session, and the question was shelved until, in 1924, a Committee was appointed to study "The Application of the Representative Method in Statistics". The Committee consisted of Professor A. L. Bowley, Professor Corrado Gini, Mr. Adolph Jensen, M. Lucien March, Professor Verrijn Stuart and Professor Franz Zizek.

Their report was presented at the Rome session of the Institute in 1926. In it Jensen dealt with the practical application of sampling, whilst Bowley (1926) treated it theoretically.

A wealth of interesting detail was presented by Jensen: his criticisms of insufficiently repre-

1951]

sentative investigations, his analyses of the results of those investigations which could properly be called representative, and much also that was to prove of great significance.

The most important point concerning the theoretical aspect was the introduction of a new design of sampling, that of purposive selection. Till then the random type and the stratified type of sampling were the only two in general use*. Experiments on the purposive method of selection had already been carried out†: the novel aspects involved were the sampling by groups instead of individual units and the intentional dependence on correlation (between the quantity sought and one or more known quantities). That the intra-class correlation would also be involved was not recognized till much later.

In the discussion on these reports the objections made over two decades previously to the representative method as first proposed by Kiaer were not advanced, partly because of the theoretical background so carefully prepared by Bowley, and partly because in the intervening years constant use of the method had established its worth. The recommendation accepted by the Institute shows the advance that had been made. It reads:

"The International Institute of Statistics . . . I. . . calls attention to the very considerable advantages which can be obtained by applying the Representative Method under the following conditions:—

"The results of a partial investigation should only be generalized provided that the sample used is in its nature sufficiently representative of the totality. In such respects the sample may be selected in different ways; the following two main cases, however, are to be distinguished:

"A. Random Selection: A number of units are selected in such a way that exact equality of chance of inclusion is the dominant rule . . . ;

"B. Purposive Selection: A number of groups of units are selected which together yield nearly the same characteristics as the totality. In order to have any knowledge of the precision of the estimates, it is necessary that sufficient groups should be included to allow the variations between the characteristics of the groups to be measured . . . ;

"II. Recommends that the investigation should be so arranged . . . as to allow of a mathematical treatment of the precision of the results, and that with these results should be given an indication of the extent of the error to which they are liable;

"III. Repeats the wish . . . that in the reports on the results of every representative investigation an explicit account in detail of the method of selecting the sample adopted should be given."

It is a curious fact that though the stratified type of sampling has been in use for nearly as long as the random type, it was not recognized in this report as a sampling type on the same plane as the random or purposive selection. There is no denying that it should be so considered for, by it, the selected sample can be made to approximate a "representative miniature" of the universe.

However, with this report, we are at the stage when the representative method has at last been recognized as of use in statistical investigations; when theory has at last started to be systematically developed; when one can confidently employ the sampling method in the collection of statistics and regard the results so obtained as properly "genuine statistics"; and finally, in deciding on the sampling design to use in any particular investigation, one can improve the accuracy of the results of such investigation based on theoretical and, therefore, purely objective considerations. This last fact leads to the next equally important stage of developing alternative sampling types or designs, where the previously accepted types or designs are found to be inaccurate, or to be difficult or impossible to apply, because of imposed limitation.

Professor J. Neyman, in the *Journal of the Royal Statistical Society* (1934), gave a theoretical

* Although it wanted another eight years before the theory of the stratified type was fully developed by Professor J. Neyman.

† Jensen's inclusion of Kiaer's investigations in the category of "purposive selection" is not strictly correct. It is true that Kiaer employed the "Method of Controls"; but while for purposive selection controls are used in the selection of groups for sampling and the selected groups are then completely observed or interviewed, Kiaer's method did not impose these restrictions. He used these controls merely to stratify his groups (towns or country communes) in the first place, and the selected groups (presumably selected by random selection) were further stratified. His controls were used *after* the surveys for testing the representative character of the selection observation units. To illustrate this we have only to refer to the safeguard he mentioned for the survey on the health insurance scheme in the Berne session of the Institute in 1895. Further, his selected groups were not completely interviewed, but were sampled in proportion to the population according to the general census of 1891.

criticism of the method of Purposive Selection. In doing so he placed the methods of stratified and group sampling on a sound theoretical basis.

But that was not all that Neyman achieved. Until then the theory of estimation was mainly that of "point estimation" based on Bayes' Theorem of Inverse Probability. This requires "the knowledge of probabilities *a priori* attached to different admissible hypotheses concerning the values of the collective characters of the population . . .", so that "we are met with conclusions based, *inter alia*, on some quite arbitrary hypotheses concerning the probabilities *a priori*, and Professor Bowley accompanies his results with the following remark: 'it is to be emphasized that the inference thus formulated is based on assumptions that are difficult to verify and which are not applicable in all cases' ". Proceeding along a different track, Neyman elaborated on and refined the theory of "interval estimation", as suggested by Professor R. A. Fisher "to remove the difficulties involved in the lack of knowledge of the *a priori* probability law". This new method of estimation, later further investigated by E. S. Pearson, S. S. Wilks and many others, became the recognized theory of estimation.

R. A. Fisher took another important step in the development of sampling theory. His work was concentrated largely on biological and agricultural research, but was later found to be of great importance to general sampling problems. The researches of R. A. Fisher and his contemporaries were concerned with agricultural field experiments, where the repetition of each treatment only a few times rendered the procedure of estimating the error of each treatment mean from deviations of the yields of the individual plots from that mean incompatible with theoretical requirements for precision, and there was the additional difficulty due to the fact that each replicate of the experiment was arranged in a compact block of plots on the ground to eliminate fertility differences as far as possible.

Fisher's technique of the analysis of variance enabled error estimates from different treatments to be pooled, while eliminating variation due to blocks or other features of the layout of the experiment. To ensure validity of the error-estimates the principle of randomization was introduced.

Various experiments based on the new technique were carried out in the Rothamsted Experimental Station and other experimental centres in England by such authorities as Fisher, Mackenzie, Clapham, Irwin, Cochran, Wishart, Yates, Zacopanay, and others. Their results were published in various specialist journals and summarized by Yates in 1946 (Yates, 1946, Irwin, 1929, 1938). Fisher, (1925) presented a fully systematized theory of experimental designs and analysis.

The first application of the new technique to sampling problems was made in 1929 by Clapham, who estimated the yields of experimental plots of cereals from a number of small sampling units cut from each plot, and used the analysis of variance to calculate the sampling errors to which sampling units of various types were subject. The method was further tested by Clapham in 1931, and its efficiency was thoroughly examined in 1935 by Yates and Zacopanay. Thus the way was clear for the development of sampling techniques applicable to many agricultural and biological problems, in which the sampling problems were approached from a new angle, namely, that of estimating sampling errors from the results of the observations. By means of this new approach it was possible not only to ascertain the adequacy of the sampling actually undertaken, but also to increase the efficiency of future sampling of the same type of material.

Yates (6) gave the principles on which this new work was based:

"(1) If bias is to be avoided, the selection of the samples must be determined by some process uninfluenced by the qualities of the objects sampled and free from any element of choice on the part of the observer.

"(2) If a valid estimate of sampling error is to be available each batch of material must be so sampled that two or more sampling units are obtained from it. These sampling units must be a random selection from the whole aggregate of sampling units that can be taken from the batch of material, and all the sampling units in the aggregate must be of approximately the same size and pattern and must together comprise the whole of the batch of material".

The first condition was satisfied by the statisticians who drew up the report to the International Institute of Statistics in 1926. The second condition embodied the really new advance. As Yates wrote: "Realization of the functions of strict processes of randomization in agricultural field experiments had led to a corresponding realization of its importance in providing a valid estimate of error in sampling. 'At random' no longer meant 'haphazard'. Again, the analysis

1951]

of variance, by making possible the pooling of estimates of error and the separation of components of error which were not homogeneous, enabled the number of independent sampling units taken from each batch of the material to be reduced to a small number, and so permitted the use of relatively complicated sampling schemes often involving sampling in two or more stages".

Applying this to sampling in social and economic research, the first point to make is that experiments cannot be replicated as can treatments in agriculture, mainly because in most cases conditions cannot be controlled, and where they can the expense would be prohibitive. Nevertheless, the new technique makes possible really valid estimation of sampling errors in stratified sampling to determine the efficiency of different types of sampling units, in sub-sampling, line sampling, and other sampling designs. It thus facilitates the selection of the most appropriate design for various conditions and limitations.

The new technique has the added advantage that, where the natural units of the population being surveyed vary widely in size and must be taken as they are, it enables the efficiency of such units to be determined.

The development of the t and z tests enabled error-estimates as calculated by the analysis of variance technique to be used as a basis for exact tests of significance. The publication by Fisher in 1935 of "The Design of Experiments" to a certain extent completed this phase of the development as applied to agricultural and biological experiments. It has yet to be satisfactorily applied to social economic problems.

While the analysis of variance technique was being developed, another important phase of sampling theory was initiated. Combinatory analysis was applied by Professor Carver (1930) to the estimation of errors in sampling. He was the founder of the *Annals of Mathematical Statistics*, and in the first volume of that journal he outlined his new technique. By means of the new theory, error-estimates could easily be calculated for almost any type or design of sampling, and, in conjunction with the analysis of variance technique, the general outline of sampling theory reached its final form about 1935. The present form of combinatory analysis as applied to sampling theory is the work of Professor Paul S. Dwyer, whose work in the *Annals of Mathematical Statistics* in 1938 could be regarded as a continuation and completion of the work started by Carver (Dwyer, 1938).

Just before the outbreak of the Second World War the development of sampling theory and its application to social and economic research shifted from Europe to America.* This does not mean that since 1938 sampling theory was not developed or that sampling surveys were not undertaken in England and elsewhere in Europe: it does mean that where there was development of the theory it was perhaps less systematic or co-ordinated elsewhere than in the United States. This last fact can be attributed mainly to the lack of a Central Statistical Agency (corresponding, for example, to the Bureau of the Census in the U.S.A.) to undertake full-scale sample surveys to test the validity of any sampling design as theoretically developed by its technical staff, or to decide on any survey that it deemed should be undertaken. Even before this, sampling theory had not been neglected in the United States. Carroll D. Wright, working in Massachusetts, was indeed a pioneer in sampling, holding a parallel position to that of Kiaer at the end of the last century. The main reason for regarding Kiaer as the true pioneer is that, while both of them had the foresight to recognize the importance of sampling in social and economic research and the courage to apply it in obtaining official statistics for the different statistical bureaux of which they were chiefs, Kiaer was the first to point the way to a systematic development of the problem of sampling and to present it to the world for further development. Kiaer was the better-trained theoretical statistician, applying his theory, crude as it was, to the collection of sample statistics, while Wright was the practical statistician *par excellence*.

Wright's first large-scale statistical investigation was the Massachusetts Census of 1875, taken under his direction as Chief of the then newly-organized Bureau of Labor. This Bureau was the first of its kind in the United States, and indeed in the world, for, though statistical bureaux then existed in many European countries, they were concerned with all types of statistics—demographic, social, economic and so on. The Massachusetts Bureau of Labor, owing largely to

* In agricultural and biological experimentation, the work of the Rothamsted Experimental Station, and other experimental stations in England under such eminent statisticians as Professor Fisher, Clapham, and later on, Dr. F. Yates, enabled the development and application of sampling theory to be kept on a high plane throughout the War.

Wright's inspiration and guidance, began a new field in governmental statistics, that of industry and labour. Since then, 34 similar State Bureaux have been inaugurated in the United States.

In 1884 Wright was chosen to organize the National Bureau of Labor and to extend his work from one state to the entire U.S.A. From then until his retirement from the position of National Commissioner of Labor in 1904, to become President of the newly created Clark College at Worcester, Mass., he succeeded in making the National Bureau a positive force in the industrial development of the nation's planning. He published a long series of reports covering the entire field of labour questions.

Unfortunately this long series of reports reveals very little of the actual method employed by Wright to obtain "representative" samples. That he did use the representative method, as understood at that time, and not any random, haphazard method of selection, is clear from his communication to Kiaer, which Kiaer read at the Budapest session of the International Institute of Statistics in 1901: "The experience of the U.S. Department of Labour has continually strengthened my own views as to the value of representative statistics. The first annual report (Industrial Depressions), the fourth (Working Women in Large Cities), . . . are all emphatic evidences of the values of this method, while nearly all the special reports published in our bi-monthly *Bulletin* add to the weight of the evidence. In fact, offices like this and the State Bureaus of Labour Statistics must use the representative method; and it is best that they should, for on most of the topics on which they deal representative facts are quite sufficient at least when we consider the vast cost of securing statements of aggregates.

"So, taking all things into consideration, I am of the opinion that the conclusions given in your St. Petersburg report and your more detailed studies in the *Allgemeines statistisches Archiv* are eminently wise and sound".

As Wright did not make clear the methods of selection of his samples, the credit for the systematic development of the theory of sampling rests among European statisticians. But the bold and farseeing step of applying sampling theories to the collection of government statistics on a vast scale, independent of the census, secured Wright's place among the pioneers of sampling. State statistical departments were organized, modelled on the Massachusetts Labor Bureau; Federal Bureaux of Statistics were started, not to control the statistical departments of the various States, but to co-ordinate their work, and simultaneously to collect nation-wide statistics independently of the State departments. These Federal Bureaux followed the pattern he had developed.

We are here concerned only with the development of governmental statistical departments in so far as it advanced the theory and practice of sampling. Here, too, statisticians in the United States of America were the first in the field. True, the British Ministry of Labour had in the twenties taken samples of "insured work-people unemployed" of several categories (Hilton, 1924, 1928), and sampling was also used in the calculation of the first British Cost of Living Index Number. Several European countries, for example, Norway, Denmark, Sweden, Hungary, and Italy, had also employed the sampling method in the collection of their government statistics. But their scale was by no means vast, and any application of the sampling method was spasmodic. Thus there was not in any country outside the U.S.A. any annual, or regular, sample surveys, while in the State of Massachusetts an annual sample survey of business was started at the beginning of the century, followed thereafter by the biennial Statistics of Business for the whole of the United States. Both these steps were taken under the direction or at the suggestion of Wright.

Not only in the governmental departments has this development been rapid, but also in private institutions and universities, as well as in the co-operative efforts of the public and private agencies. In this regard there are significant differences between the U.S.A. and other countries. For example, in England during the first decade of the present century, under the guidance of Bowley, researches had been carried out into the social and economic conditions of several towns—Reading, Northampton, Warrington, Stanley, Bolton, and others. These were sponsored by institutions such as the Ratan Tata Foundations. The great investigation into the London life and labour in the late twenties was carried out largely at the instance of the London School of Economics. But such endeavours were spasmodic, and though intensive in themselves did not coalesce into any nation-wide projects—further, they relied on sampling methods previously used by Bowley, and did not carry out new researches into sampling methods; the resources to do so were inadequate.

In the U.S.A. the picture was altogether different. There the efforts of the charity organization

1951]

movement, the study of economic and social problems by the universities and the development of market research all helped towards the development of the techniques of social investigations.

The Pittsburgh Survey of 1907 was the first complete social survey—not merely a sample survey (Kellogg, 1914). Directed by Paul U. Kellogg, financed by the Russell Sage Foundation, it purported to be “an appraisal . . . of how human engineering had kept pace with mechanical in the American steel district . . . an attempt to throw light on these and kindred economic forces, not by theoretical discussion of them, but by spreading both the objective facts of life and labour . . .”. Its subject matter included the study of wages, hours of work, work accidents, questions of industrial relations and conditions, family budgets and home conditions of steel workers, and a host of other questions. It made use of the case-work method developed by B. S. Rowntree in his York Inquiry in England, and by Charles Booth in his inquiry into the “Life and Labour of the People in London”. But while in England the case-method survey was, after the findings of Bowley, not used at all, or used, as in the second survey of the “London Life and Labour”, in conjunction with the sampling method,* in the United States its use increased rather than diminished. Thus the next large-scale survey, that of Springfield, Ill., in 1914, had as its “method of investigation . . . the study of the records, published and unpublished, compiled and uncompiled, of organizations and institutions in the community and of outside agencies which had data on Springfield; personal visits to and observation of Springfield organizations and institutions in operations; the gathering of facts through intensive studies or tests planned for certain sections of the city, or of the population; special study of the activities of particular agencies or groups of agencies and interviews with officers in charge; first-hand observation of conditions throughout the city; written inquiries and personal interviews with individuals in possession of experience or information pertaining to the problem in hand; and study of legislation relating to local conditions and procedures”. So that the survey, besides applying the case-method, used the experience of the civic and social workers in finding facts relating to current social situations, the experience of the engineer in understanding the structural relations of different types of community conditions, of the surveyor in relating his work and study to a definite geographic area, of the social research worker, of the physician, city planner and social worker in bringing the problem down to human terms, of the journalist and publicity worker in interpreting facts in terms of human experience. In short, such social survey is a co-operative undertaking which applies scientific method to the study and treatment of current related social problems and conditions having definite geographic limits and bearings. It endeavours to publicize its facts, conclusions and recommendations so that they shall be the common knowledge of the community and a force for coordinated action.

At the same time the specialized survey was being developed. For example in Cleveland there was a series of investigations each dealing specifically with one subject—education, recreation, criminal justice, hospitals, and health. In these it was neither easy nor desirable to employ the sampling method. Intensive investigation is the only sure way of bringing out the required information; moreover, the limited scale of the survey does not warrant the use of sampling to select a certain proportion of units for observation. General and special surveys undertaken within a definite geographic area, such as a city, do not necessarily involve sampling.

Since then social surveys have flourished in the United States. Several thousand projects on special studies and several hundred general surveys have been completed. There were many institutions sponsoring and participating in surveys; university and college organizations; agricultural experiment stations; health and medical associations; family welfare and charity societies; councils of social agencies; child labour committees; consumers' leagues; bureaux of municipal research; commissions of efficiency and economy; housing committees; playground and recreation committees; committees on industrial relations; market research associations; and many others. Practically every type of private organization interested in improving the conditions under which people live and work, and a large number of municipal, state and

* In general one can say that the case-method was used to obtain information which is not easily measurable, as in the second London Survey, the “local distribution of poverty, street by street, and . . . direct information as to poverty due to personal habits as distinct from that due to deficient income”; while the sample method was used “to obtain detailed and precise information on the composition of the working-class families, housing accommodation and rent, number and ages of earners, total income, etc.”, i.e. information which could be measured.

federal bodies, have made the study of social conditions an important feature of their regular work, not only to give citizens the information necessary to form intelligent opinions upon matters of public concern, but also to develop plans for their current work.

In the first decade of the century there was in the U.S.A. a new development in social surveys. Federal agencies began to co-operate with private agencies. The first work of this kind was the survey of individuals and schools in the city of Richmond, Virginia, carried out, in co-operation, by U.S. Bureau of Education, the U.S. Bureau of Labor Statistics, the National Society for the Promotion of Individual Education, the Russell Sage Foundation of New York City and the city of Richmond.

Yet another development was the institution of more or less permanent survey or research bureaux in different localities.

There were also agencies which studied, not the social welfare or conditions of the people, but the consumption and expenditure habits of some part of the country, thus trying to determine whether a particular industry could with advantage be established, or whether a particular commodity could be sold easily, and various other phases of the problem of market research. Projects were undertaken by national newspapers to fathom public opinion on national affairs, such as Prohibition, Presidential elections, and many other matters.

It is therefore not surprising that sampling developed with such rapidity in U.S.A. Where the surveys are on general lines and national in character, or where market research schemes have to cover, not one state or one district, but the whole country, case-method, or typological, or intensive methods of investigation are impossible, or if possible, are too expensive.

As early as the beginning of the century there had been sampling surveys on social conditions, an example of which was provided by the study of living conditions and migration of the Upper East Side of New York (Mark, 1907). Houses were the units of investigation. A number were chosen as representative of conditions in their particular blocks, or as consisting of families typical of a class more widely distributed throughout the district. Of course, no account of the method of selection and justification for the selection was given, as was also true of nearly all sampling surveys undertaken at the time.

At about the same time the case-method investigation of the American charity organizations, of C. Booth in his survey into the "Life and Labour of London", and of Professor Lindsay in his report to the National Conference of Charities (in 1899), was criticized by Kleene (1908), chiefly in connection with its use in surveys for the study of causes of pauperism. He adduced two reasons for the inapplicability of the case-method—the relative paucity of recorded information, and the difficulty amongst what there was of interpreting the causative contribution of particular social ills. He thus cast doubt on its use, for measuring the effects of social conditions—merely counting cases—assuming that they are of equal value, and not utilizing proper methods of selection vitiated the use of the method unless it were applied conjointly with an intensive survey, as had been done in some of the specialized fields we have mentioned above.

We need not mention every survey that does employ the sampling method. It is sufficient to say that by the thirties the development of sampling for general social surveys, and sometimes for special surveys; had advanced so far that hardly a survey failed to use it for the selection of units for observation. Thus sampling was used in surveys into living conditions, population migration, standard of living, family incomes, expenditures and savings, education problems, farm conditions, farm acreages, relief family conditions, relief and rehabilitation problems, racial problems, health surveys, housing surveys, effects of rural credit, psychological research, occupational characteristics of workers, fertility questions, and many other problems of social and economic significance. Marketing research schemes, consumer opinion and consumer purchases surveys, too, make considerable use of this new method. Public opinion polls, straw votes, newspaper surveys, all make use, sometimes unwisely no doubt, of sampling. And lastly, sampling is now being increasingly used in industry for research on quality control of standardized products.

In the theory of sampling, too, there had been important advances, so that the criticism can hardly be raised that theory does not keep pace with practice. Indeed it is more the other way round; for it is difficult, if not impossible, to develop social studies to such an extent as to endow them with the status of experimental research. Each survey costs so much time, money and labour; social conditions are difficult to control, and are so complex that although theories for

1951]

"ideal" sampling designs have been developed by mathematical statisticians ("ideal", that is, in various circumstances and under various limitations), no "experiments" are possible to prove their usefulness, and consequently they have to wait until some agencies have made use of them. The U.S. government bureaux are, of course, an exception. They have professional experts to develop new theories for particular circumstances, and at the same time have the resources and boldness to put these into actual use. Thus the double sampling design developed by Neyman was employed by the Bureau of Home Economics and that of Agricultural Economics in the study of rural and urban family expenditures and savings; the sub-sampling design in connection with block and area sampling and the study of the relative efficiencies of various sizes of sampling units for estimating the characteristics of a finite population, were developed by the Bureau of the Census (notably by such statisticians as Hansen and Hurwitz), and employed by it for the survey of the Labour Force; the theory of area sampling was developed and used by the Department of Agriculture in its plan for a master sample of agriculture; the theory of questionnaire-interview-follow-up and its employment was perfected by the Bureau of the Census in its survey of business sales; the theory of grid or "systematic" sampling for survey of lumber resources and of lumber produced, by the Bureau of the Census; the theory of matching for regularly repeated surveys was designed and put into practice by Jessen for the Department of Agriculture.

While the U.S.A., chiefly, is to be credited with such rapid advances in the development of sampling theory and its application, other countries have not been idle in both these aspects. The most notable example is India, where since the establishment of the Indian Statistical Institute on December 17th, 1931, for research work and for the training of statisticians, both the theoretical and practical aspects of sampling have developed rapidly and successfully, especially in the field of large-scale crop surveys, the field which has been aptly designated statistical engineering by Professor Mahalanobis, the guiding spirit of the Institute for the greater part of its existence to the present day.

Two types of surveys were developed by this Institute as contract works for the Government, from the grants for which it obtained the greater part of its income. The first type is the large-scale statistical engineering project to obtain reliable estimates of acreage, rate of yield per acre, and total production of food and fibre crops, such as rice, wheat, jute, etc., or of economic or demographic factors relating to indebtedness, unemployment, destitution, paddy land, plough cattle, birth and death rates of rural families. The second is more localized, relating to cost and level of living, housing, food-consumption, consumer surveys, public opinion, and so on. For the first type of surveys Professor Mahalanobis (1944) has developed a comprehensive theory of area or grid method of sampling, and has further introduced the idea of cost and variance functions for the determination of an optimum or most economical design for sampling in any particular instance.

Also, in connection with large-scale surveys, where the work has to be continued at suitable intervals (such as yearly, quarterly, etc.), the exploratory method of sampling has been developed and used by the Institute. A survey is first carried out on a very small scale with the primary object of collecting basic information required for preparing an efficient design for later surveys. Sometimes such preliminary surveys have to be carried out more than once, and the scale of operations is gradually increased until finally the whole area or universe is fully covered. For example, in the Bengal crop survey, a pilot survey was first carried out in 1937 covering only 124 square miles at a total cost of about £1,100. In 1938 a second survey was organized, in the light of the experience gained in the previous season, on a larger scale covering about 400 square miles, at a cost of £2,500; next year the total area covered was nearly 2,600 square miles, at a cost of £6,000. In 1940 the area covered was nearly 20,600 square miles, at a cost of £8,100; and finally in 1941 the whole jute tract of Bengal, measuring about 60,000 square miles, was surveyed at a cost of £10,100 (Mahalanobis, 1946). These "pilot" surveys provided sufficient experience to expedite the exploratory phase of future surveys, especially where conditions are expected to be similar, as, for example, the Bihar crop survey, where the exploratory work was done in only two districts, covering about 8,000 square miles, from February to April, 1944. Furthermore, the exploratory phase is useful in providing the necessary training to the field staff and the computational and technical staff.

In the second type of surveys work has been carried out during the war on the study of family budgets, housing and other economic conditions of factory workers in an industrial area north

of Calcutta, and another inquiry on labour conditions carried out in Nagpur at about the same time. The design of the surveys enabled the analysis of variance to be carried out, and it might be mentioned that these provide practically the first instances of the application of the Fisherian analysis of variance in socio-economic surveys, especially in respect of personal equations or bias of the investigating staff, thus enabling this type of error to be separated and eliminated.

India can therefore safely claim to rank with the United States as amongst the foremost users of the sampling method in social and economic research. And it is a very happy combination, for in the United States we have the typical example of an industrial and highly developed country, while in India the conditions approximate more nearly to those of a country not so highly developed, or, more specifically, to the conditions of those countries, which, like China, have no genuine statistics, and where such statistics, if they are to be obtained at all, have to be obtained mainly by sample surveys, for which the experience of India will serve as a guide and as an example worthy of imitating.

Thus, half a century after Kiaer and Wright started the use of sampling in large-scale social surveys, and four decades after Bowley developed the statistical theory of sampling, we are now in a position which many other sciences and scientific theories have taken centuries to attain. To-day nearly every social survey worthy of the name is making use of the sampling method, correctly or otherwise, depending on the understanding on the part of the planners of the theory, of the circumstances under which they have to carry out the surveys, of the materials, human and otherwise, at their command. Any lack of understanding of the sampling theory is due largely to the fact that, with the exception of a chapter or so in nearly every text-book on Statistics, mainly on random and stratified sampling, no real effort has been made to systematize all the sampling types and designs which have been separately developed in practically every learned journal of statistics, agriculture, eugenics, marketing research, public opinion, social research, economic research, etc.—with the exception, that is, of the recent work of Dr. F. Yates (1949). For there are, in actual fact, two very important related aspects of sampling which every sampler must take into consideration:

(a) The static aspect which *treats* every sample survey for its own immediate worth. Under it every sampling plan has for its aim the attainment of the maximum precision, and therefore information, possible at a given cost, time, labour and other available materials, or, alternatively, a given precision or information at the minimum cost, time, labour.

(b) The dynamic or sequential aspect which does not, of course, exclude the static aspect. Under this aspect a sample survey, besides its immediate purpose, as stated under (a), can serve as a quasi-laboratory experiment for future surveys. It should enable a thorough analysis of the particular sampling plan, of the particular sampling unit used, the particular sampling ratio, the particular method of inquiry, etc., to be carried out so that future surveys, carried out under more or less similar conditions, can be planned with greater assurance of success, or so that modifications can be introduced to obtain greater precision or information.

References

- Bowley, A. L. (1906), *J. R. Statist. Soc.*, 69, 548.
 — (1926), *Bull. Inst. Int. Statist.*, 22, Liv. I, [6].
 Carver, H. C. (1930), "Fundamentals of the theory of sampling", *Ann. Math. Statist.*, 1, 10.
 Census of England and Wales, 1861, Vol. III, General report, pp. 93–99. [Tables 32–42.]
 Dwyer, P. S. (1938), *Ann. Math. Statist.*, 9, 1, 97.
 Fisher, R. A. (1925), *Statistical Methods for Research Workers*. London: Oliver & Boyd.
 Hilton, J. (1924), "Inquiry by sample", *J.R. Statist. Soc.*, 87, 562.
 — (1928), "Some further inquiries by sample", *ibid.*, 91, 519.
 Irwin, J. O. (1929), "Crop forecasting and the use of meteorological data in its improvement", *Conference of Empire Meteorologists, Agric. Section*, 2, 220.
 — Cochran, W., and Wishart, J. (1938), "Crop estimation and its relation to agricultural meteorology", *Supp. J. R. Statist. Soc.*, 5, 1.
 Kellogg, P. U. (1914), *The Pittsburg District: Civic Frontage*. N.Y.: Russell Sage Foundation.
 Kiaer, A. N. (1895), "Observations et expériences concernant les dénombrements représentatifs", *Bull. Inst. Int. Statist.*, 9, Liv. I, 176.
 — (1899), "Sur les méthodes représentatives ou typologiques appliquées à la statistique", *ibid.*, 11, Liv. I, 180.
 — (1901), "Sur les méthodes représentatives ou typologiques", *ibid.*, 13, Liv. I, 66.
 — (1899), "Die repräsentative Untersuchungsmethode", *Allg. Statist. Arch.*, 5, 1.

1951]

- Kleene, G. (1908), "Statistical study of causes of destitution", *J. Amer. Statist. Ass.*, **11**, 273.
Mahalanobis, P. C. (1944), "On large-scale sample surveys", *Philos. Trans.*, **B**, **231**, 329.
— (1946), "Recent experiments in statistical sampling in the Indian Statistical Institute", *J. R. Statist. Soc.*, **109**, 325.
Mark, M. L. (1907), "The Upper East Side: a study in living conditions and migration", *J. Amer. Statist. Ass.*, **10**, 345.
Neyman, J. (1934), "On the two different aspects of the representative method", *J. R. Statist. Soc.*, **97**, 558.
Yates, F. (1946), "A review of recent statistical developments in sampling and sampling surveys", *ibid.*, **109**, 12.
— (1949), *Sampling Methods for Censuses and Surveys*. London: Griffin.

THE SOURCES AND NATURE OF STATISTICAL INFORMATION IN SPECIAL FIELDS OF STATISTICS

STATISTICS OF THE CHEMICAL INDUSTRY

By A. J. H. MORRELL, F. P. STEVENS and E. W. TALBOT

AN attempt is made in the following pages to indicate the sources of the principal statistics of the chemical industry in the United Kingdom, to define their scope, and to add any explanation that may be necessary to facilitate their interpretation.

Definition of the Industry

Most people have merely a subconscious idea of what constitutes a chemical. They tend to regard it as a substance which is somehow highly reactive, perhaps dangerous to take internally or corrosive to the touch. The chemical industry to them is the industry in which such highly artificial products are made, a notion which historically is fairly near the mark. However, out of the primitive associations of the industry there has grown the production of a multitude of substances with many differing characteristics, some to be treated with care, others as innocuous as a loaf of bread, but all regarded beyond doubt by those in the trade as "chemicals", if only, or mainly, because they are the legitimate offspring of this single branch of industrial evolution.

Many other manufactures involve chemical processes, for instance, the reduction of ores in the blast furnace to produce iron, but no one regards iron as a chemical, since it is the product of another well-established industry. It is quite impossible, therefore, to define a chemical industrially except as a product of the chemical industry, as historically evolved and as now generally understood by those connected with the trade. Although this may sound somewhat indecisive, in defining the industry strictly for statistical purposes there are actually no problems in considering for inclusion that part of the industry which manufactures the more typical chemicals. The differences which have arisen in practice relate to the variety of satellite industries, which have either branched off the main chemical industry or (if the reader will excuse the mixed metaphor) gravitated into its orbit by the attraction of common techniques, or for economic reasons. Explosives, plastics, paints, matches, petroleum refining and drugs are examples of such industries. In compiling statistics of the chemical industry, it is usual to include a selection of these satellites, but the different authorities are not unanimous in their selection.

The Standard Industrial Classification, introduced in February, 1948, and now used for the Censuses of Production, Distribution and Population, the Index of Industrial Production, Ministry of Labour statistics of employment, etc., includes the following industries in Order IV—Chemical and Allied Trades:

Coke Ovens and By-product Works.

Chemicals and Dyes:

1. Dyes and dyestuffs.
2. Fertilizers, disinfectants, etc.
3. Synthetic resins and plastics materials.
4. Other chemicals.

Pharmaceutical Preparations, Toilet Preparations, Perfumery:

1. Pharmaceutical preparations.
2. Toilet preparations and perfumery.

Explosives and Fireworks.

Paint and Varnish.

Soap, Candles, Glycerine, Polishes, Ink and Matches:

1. Soap, candles, glycerine.
2. Polishes, ink and matches.

Mineral Oil Refining.

1951]

Other Oils, Greases, Glue, etc.:

1. Lubricating oils and greases.
2. Oil seed crushing and refining of vegetable and marine oils.
3. Animal oils and greases and fish liver oils.
4. Glue, gum, paste, etc.

The classification of import and export statistics is very different. Admittedly the Standard Industrial Classification deals with industries and the trade statistics with products, but greater uniformity might be expected. Class III, Group O, "Chemicals, Drugs, Dyes and Colours", includes:

Chemical manufactures and products (other than drugs and dyestuffs).

Drugs, medicines and medicinal preparations.

Dyes and dyestuffs (except dye-woods and raw dyeing substances) and extracts for dyeing and tanning.

Paints, pigments, colours and extenders for all purposes, not elsewhere specified.

But petroleum products and soap appear in Class III, Group P, "Oils, Fats and Resins, Manufactured", and explosives, plastics materials, matches, writing ink, etc., in Class III, Group U, "Miscellaneous Articles Wholly or Mainly Manufactured".

Before the Standard Industrial Classification was introduced, i.e., up to various periods of 1948, the position was almost chaotic. The Ministry of Labour, for example, gave three different groupings for "Chemicals, Paints, Oils, etc." in its statistical tables. In the Industrial Analysis of Numbers Employed there were five headings, namely:

Coke Ovens and By-Product Works.

Chemicals.

Explosives.

Paint, Varnish, etc.

Oil, Glue, Soap, Ink, etc.

Coke Ovens and By-Product Works, however, were included in "Non-Metalliferous Mining Products" both in the Industrial Analysis of Numbers Unemployed and in the half-yearly tables of Average Earnings and Working Hours. In the latter, Chemicals and Explosives appeared as one industry.

The 1935 Census of Production, the last full census not based on the Standard Industrial Classification, had a large group, "Chemicals and Allied Trades", with the following schedules:

Chemicals, Dyestuffs and Drugs Trade.

Fertilizer, Disinfectant, Glue and Allied Trades.

Soap, Candle and Perfumery Trade.

Paint, Colour and Varnish Trade.

Seed Crushing Trade.

Oil and Tallow Trade.

Petroleum Refining Trade.

Explosives and Fireworks Trade.

Starch, Blue, Polishes and Kindred Trades.

Match Trade.

Ink, Gum and Typewriter Requisites Trades.

Plastic Materials appeared in "Miscellaneous Trades", as also did Coke and By-Products and Manufactured Fuel.

A brief mention may be made here of the "Report on the Chemical Industry" published in 1949 by the Association of British Chemical Manufacturers, hereafter to be called the "A.B.C.M. Report". The field covered in this report is defined as "heavy chemicals, industrial gases, fertilizers, dyestuffs, medicinal and other fine chemicals, explosives, plastics and synthetic resins, but not the compounding of chemicals to make such products as paints, insecticides, sheep and cattle dips and pharmaceutical preparations". This definition was adopted, not because it was considered ideal, but for reasons of expediency.

Units of Measurement

Solid products of the chemical industry are usually expressed in units of weight; liquids are measured in some cases by weight and in others by volume or cubic capacity, the choice of unit being conventional and arbitrary.

Gases are sold by the cubic foot (or cubic metre), understood to express the volume the gas in question would occupy at normal atmospheric pressure and a standard room temperature. In practice the gases are handled commercially in compressed form, and occupy a much smaller volume than that stated. Some "gases" which are sold in cylinders similarly under compression, but in liquefied form, are expressed by weight instead of by volume.

A feature of the chemical industry is that many of its products are sold diluted, so that a knowledge of the strength is requisite to the proper interpretation of any statistics relating to them. Dyestuffs, for instance, are compounded of the pure dye and various additives required to improve their application or for their standardization. Statistics frequently show the gross weights, which may be misleading as measures of tinctorial value. Fortunately, the strengths of chemical products are often indicated, as a rule by showing the percentage content of the essential ingredient.

In the case of certain products dissolved in liquids, however, e.g., caustic soda solution in water, the strength is sometimes expressed in terms related to the specific gravity. In the United Kingdom the unit is the degree Twaddell ($^{\circ}$ Tw.), in the United States and the European Continent the degree Beaumé ($^{\circ}$ Bé), though the latter degrees differ a little from each other on the two sides of the Atlantic. "Twaddell" and "Beaumé" are the names of the hydrometers used to measure the densities of the solutions, the degrees being the graduations marked on them. Such units are conventional and arbitrary except inasmuch as the specific gravity may be calculated from them by means of simple formulae. Tables are published showing the actual percentage of ingredient for each degree unit.

When the statistics relating to a particular product cover materials of varying strength, and where separate figures are not given for each strength, it is customary to calculate the totals in terms of a common unit indicative of the essential content. For instance, this may be done by taking the sum of the weights of the essential ingredients contained in each of the different strength materials, or, put another way, by subtracting the amounts of diluents from the bulk total of all the materials.

In some cases, however, instead of showing the actual weights of essential ingredients, it is the custom to express the amount of a product by the weight of only a part of such ingredient. Thus sulphuric acid (H_2SO_4) is sometimes expressed statistically on SO_3 content. Similarly, fertilizers are measured by their content of ingredients useful to plants, i.e. the chemical elements nitrogen, phosphorus and potassium, expressed arbitrarily as nitrogen (N), phosphoric acid (really phosphorus pentoxide— P_2O_5) and potash, so-called (K_2O). Solutions of varying strength are often calculated to a standard gravity, whether in Twaddell or Beaumé units.

In the United States the unit of weight employed in chemical statistics is usually the short ton of 2,000 lb. The long ton of 2,240 lb. is used, however, for some materials of interest to the chemical industry, for instance, sulphur and rubber. The unit for physical volume is invariably the U.S. gallon, which is five-sixths of the Imperial gallon.

Overseas Trade

Details of foreign trade can easily be found in the *Annual Statement of the Trade of the United Kingdom* and the monthly *Accounts Relating to Trade and Navigation of the United Kingdom*. However, it may be useful to give an outline of the distribution of trade in chemicals, and Tables 1 and 2 show the value of imports from, and exports to, the principal countries, in 1938 and 1949, of "Chemicals, Drugs, Dyes and Colours" (Class III, Group O). Figures are rounded off to the nearest £'000.

These tables show all countries contributing over 2 per cent. of the total value, placed in order of magnitude in 1949. Data for 1938 and 1949 are taken from the *Accounts* for December, 1948 and December, 1949 respectively. It is, unfortunately, difficult to compare the two years in respect of the volume of imports from, or exports to, individual countries, but the volume of total imports of Chemicals, etc., in 1949 is estimated as 76 per cent. of that for 1938, and the volume of total exports in 1949 as 160 per cent. of that for 1938 (*Board of Trade Journal*, February 4th, 1950, pp. 237-238).

1951]

TABLE 1

U.K. Imports of Chemicals, Drugs, Dyes and Colours (III, O)

	1938		1949	
	£'000	%	£'000	%
Imports from—				
U.S.A.	2,835	20·8	6,435	25·4
Germany	3,998	29·4	4,023	15·9
France	1,032	7·6	3,760	14·8
Union of South Africa	271	2·0	1,872	7·4
Spain	52	0·4	1,207	4·8
Chile	411	3·0	1,183	4·7
Canada	636	4·7	1,118	4·4
Switzerland	858	6·3	1,093	4·3
Belgium	667	4·9	866	3·4
Netherlands	532	3·9	803	3·2
Other Countries	2,321	17·0	2,971	11·7
Total	13,613	100·0	25,331	100·0

TABLE 2

U.K. Exports of Chemicals, Drugs, Dyes and Colours (III, O)

	1938		1949	
	£'000	%	£'000	%
Exports to—				
India	2,841	12·8	10,252	11·9
Pakistan			2,468	2·9
Australia	2,076	9·3	4,780	5·6
Union of South Africa	1,765	7·9	4,389	5·1
Irish Republic	1,158	5·2	3,153	3·7
Malaya	631	2·8	2,786	3·2
British West Africa	507	2·3	2,785	3·2
Brazil	434	1·9	2,772	3·2
Sweden	541	2·4	2,686	3·1
Netherlands	467	2·1	2,669	3·1
Egypt	457	2·1	2,625	3·1
Argentine Republic	698	3·1	2,494	2·9
Hong Kong	487	2·2	2,444	2·8
New Zealand	824	3·7	2,194	2·5
Iran	136	0·6	2,139	2·5
U.S.A.	941	4·2	1,928	2·2
Denmark	392	1·8	1,925	2·2
France	735	3·3	1,847	2·1
British West Indies	380	1·7	1,829	2·1
Canada	1,154	5·2	1,811	2·1
Other Countries	5,656	25·4	26,118	30·5
Total	22,280	100·0	86,094	100·0

It must be remembered that Class III, Group O, does not correspond to the whole of the chemical industry as generally defined for statistical purposes. Furthermore, the figures for 1938 and 1949 are not strictly comparable, because basic slag and bonemeal were transferred from this group to Class II, Group N, "Miscellaneous Raw Materials and Articles Mainly Unmanufactured", in 1949.

Tables 3 and 4 show the value of United Kingdom imports and exports, in 1938 and 1949, of the principal chemical items or groups of items, including plastic materials from Class III, Group U. It is not possible to show explosives, as they are included in "Arms, Ammunition, and Military and Naval Stores" in the monthly *Accounts*, and at the time of writing the more detailed *Annual Statement* has not yet been published for 1949.

TABLE 3

U.K. Imports of Principal Chemicals, 1938 and 1949

	1938	1949
	£'000	£'000
<i>Products</i>		
Acetic anhydride	99	364
Acids	459	735
Borax	99	354
Superphosphate of lime	35	937
Glycol ethers and glycol ether-esters	74	408
Iodine	146	391
Potassium chloride (muriate)	587	6,157
Potassium sulphate	405	454
Sodium nitrate	274	795
Synthetic organic dyestuffs	1,361	863
Casein, raw	289	939
Synthetic resins	94	349
Moulding powders	14	1,374
Cellulose acetate } Celluloid }	995	{ 1,232 1,194

TABLE 4

U.K. Exports of Principal Chemicals, 1938 and 1949

	1938	1949
	£'000	£'000
<i>Products</i>		
Acids	421	1,656
Ammonium sulphate	2,053	4,855
Ammonium nitrate	170	1,888
Creosote oil	864	1,543
Copper sulphate	510	1,641
Disinfectants, insecticides, etc.	786	3,253
Lead tetra-ethyl	—	2,217
Salt (sodium chloride)	644	1,523
Sodium carbonate	872	1,995
Caustic soda	1,041	2,807
Other sodium compounds	1,003	3,191
Penicillin	—	2,539
Finished dyestuffs obtained from coal-tar	1,134	8,971
Plastic materials:		
Synthetic resins	43	1,819
Moulding powders	195	1,248
Sheet, rod, tubes, film and foil	19	2,096

Production, Consumption and Stocks

The *Monthly Digest of Statistics* and the *Annual Abstract of Statistics* give production, consumption and stocks of the following chemicals and fertilizers. (A) indicates that the item appears only in the *Annual Abstract*. Table Numbers refer to the *Annual Abstract* for 1938–1948.

Chemicals (Table 162)

Methanol (A).
 Urea (A).
 Nitric acid (A).
 Pyrites.
 Sulphur (for acid).
 Sulphur (regular).
 Spent oxide.
 Anhydrite (A).
 Sulphuric acid.
 Industrial alcohol.
 Industrial methylated spirit (A).
 Calcium carbide (A).
 Ammonia.

Fertilizers (Table 163)

Nitrogenous fertilizers (nitrogen content).
 Phosphatic fertilizers (P_2O_5 content):
 Superphosphate.
 Ground basic slag.
 Ground phosphate.
 All other phosphatic fertilizers.
 Potash (K_2O content).
 Compound fertilizers.
 Phosphate rock.

The *Annual Abstract of Statistics* also gives similar information for the following:

Plastics and Materials for Plastics (Table 164)

Synthetic resins:

Phenolic.
 Cresylic.
 Urea.
 Other.

Moulding powders:

Phenolic.
 Urea.
 Cellulose acetate.

Cellulose acetate sheet, rods, tubes and film.

"Perspex" (acrylic sheet).

Celluloid.

Polyvinyl chloride (unplasticized).

Polyvinyl chloride (plasticized).

Casein plastic materials.

Laminated material.

Production of the following coal-tar products appears in the *Annual Abstract of Statistics* (Table 142) and the *Ministry of Fuel and Power Statistical Digest for 1948 and 1949* (Table 153).

Road tar (including refined tar).
Creosote/Pitch mixture.
Creosote oil.
Pitch.
White naphthalene.
Hot-pressed naphthalene.
Crude naphthalene.
Pyridine bases.
Natural phenol.
Refined cresylic acid (all grades).
Anthracene 40/50 per cent.

The *Monthly Bulletin of the British Bureau of Non-Ferrous Metal Statistics* gives consumption of lead, zinc, antimony and cadmium in white lead and similar pigments, from which the production of these pigments can be estimated.

At the time of writing the results of the Census of Production for 1948 have not been published. The Partial Census for 1946 included Chemicals, Dyestuffs and Drugs, a Preliminary Report for which appeared in the *Board of Trade Journal* of June 12th, 1948. This covered firms engaged wholly or mainly in the manufacture of chemicals (except fertilizers and explosives), the manufacture or compounding of drugs and medicinal preparations, and the manufacture of synthetic resins and plastic materials, excluding cellulose acetate production by textile firms. The tables published were as follows:

Table I (A):	Summary, Private Firms.
„ I (B):	Summary, Government Departments.
„ II (A):	Total Make of Certain Products.
„ II (B):	Sales (Output) of Principal Products.
„ III:	Production, Exports and Imports.
„ IV:	Sales (Output) of other Products.
„ V:	Materials, Fuel and Electricity Purchased and Used.
„ VI:	Employment, Wages and Salaries.
	(A) Private Firms.
	(B) Government Departments.

Table II (A) shows the quantities of certain products made in the years 1946 and 1937, whether produced for sale as such or for use in further manufacture in the same works. Table II (B) gives sales in 1946 and output for sale in 1947. Table III has three columns giving production (or, in some cases, sales), exports and retained imports. Production in this table (although it does not say so) means total production whether for sale or for further manufacture.

It may be noted that products transferred from a factory or plant covered by one Census schedule to a factory or plant covered by a separate schedule but owned by the same firm must be entered on the first schedule as "sold", and valued as far as possible as if they had been sold to an outside firm. The receiving establishment must likewise return the goods in its materials section valued on the same basis, with allowance for any transport charges. Before the Partial Census of 1946 such products were recorded at the transfer values shown in the firm's books. This change introduced by the Partial Census applies especially to the chemical industry, in which goods frequently go through several processes, often in widely separated plants. For this reason there is greater need than in most industries to guard against duplication.

The *A.B.C.M. Report* contains an interesting chapter on "Future Trends and Expansion of the Industry," showing, *inter alia*, for various groups of chemicals, the present productive capacity and the estimated productive capacity on the completion of the expansion schemes in progress or contemplated.

Index Numbers of Industrial Production

The Official Index of Industrial Production compiled by the Central Statistical Office includes an index for "Chemicals and Allied Trades" corresponding to Order IV of the Standard Industrial

1951]

Classification (see above). The weights allotted to the component industrial groups out of a grand total of 1,000 are as follows:

Coke Ovens and By-Product Works	2.2
Chemicals and Dyes	33.0
Pharmaceutical Preparations, Toilet Preparations, Perfumery	3.9
Explosives and Fireworks	4.5
Paint and Varnish	5.9
Soap, Candles, Glycerine, Polishes, Ink and Matches	8.5
Mineral Oil Refining	1.6
Other Oils, Greases, Glue, etc.	5.7
Total Chemicals and Allied Trades	65.3

The London and Cambridge Economic Service also publishes an Index of Industrial Production, with a number of subdivisions, including one for "Group 9, Chemicals and Allied Trades", which differs in several respects from the official index. The London and Cambridge Economic Service excludes finished munitions; Coke and By-Products and Petroleum appear in a different group, "Fuel and Power"; Oil and Tallow, Ink, Gum and Typewriter Requisites are omitted for lack of data. On the other hand, the London and Cambridge Economic Service Group 9 includes Salt Mines, Brine Pits and Salt Works, which the Central Statistical Office, following the Standard Industrial Classification, includes in "Mining and Quarrying".

The weights given to the components of Group 9 of the London and Cambridge Economic Service Index out of a grand total of 3,270 are:

Chemical, Dyestuffs and Drugs	101.4
Fertilizer, Disinfectants, Glue and Allied Trades	18.0
Soap, Candles and Perfumery	19.1
Paint, Colour and Varnish	25.6
Seed Crushing	8.8
Explosives and Fireworks	8.9
Starch and Polishes	8.6
Matches	2.0
Salt Mines, Brine Pits and Salt Works	2.0
Total Chemicals and Allied Trades	194.4

It is interesting to compare the two series for Chemicals and Allied Trades for the years available:

	<i>Central Statistical Office</i>	<i>London and Cambridge Economic Service</i>
1935 { Using 1935 weights	63	66
{ Using 1946 weights	67	71
1946	100	100
1947	105	100
1948	120	117
1949	123	126

The figure usually quoted by the London and Cambridge Economic Service for 1935 is the geometric mean of the two indices obtained (i) with 1935 weights, (ii) with 1946 weights. The result, to the nearest whole number, is 69.

The differences shown here are not entirely explained by the slight differences in classification and weighting, and they serve to emphasize the extreme difficulty of measuring the production

of so complex an industry as the chemical industry. The following quotation is taken from *The Measurement of Production Movements* (pp. 28–29) by Carter, Reddaway and Stone, of the London and Cambridge Economic Service:

“The second problem, incomplete coverage of products, is well exemplified by the chemical trade. Here the number of different products is legion, and for a vast number of them no monthly statistics are available. It might theoretically be possible to record the total weight of all chemicals delivered each month, in the same way as for iron castings, and so obtain a ‘comprehensive’ series; but the objections to adding together penicillin and washing soda on a weight-for-weight basis are even greater than those with pipes and machinery parts, and the plain fact is that such a series does not exist. We are forced, therefore, to use statistics for a selection of products or product groups (e.g., synthetic dyestuffs), despite the obvious danger that our selection will not, in fact, show the same movement in output as the trade taken as a whole”

“Moreover, we were very much influenced by the need to keep the volume of work within manageable limits. In the case of chemicals this meant that if we were to cover even a moderate proportion of the trade our choice had to be mainly based on the unscientific principle of taking those products which had the largest value of output. Such a procedure is likely to lead to a downward bias in the index, because it concentrates the sample on to the staple, basic chemicals. In a progressive industry it is likely that the output of these will expand less than that of more complex products, even if we could ignore the completely new developments which had no chance of being included in the sample”

Productivity

If it is difficult to obtain a reliable index of production for the chemical industry it is, *a fortiori*, more difficult still to measure productivity, even by such simple tests as output per man-hour or output per man-year. There are, of course, objections to these simple criteria. In particular they relate output to one factor of input only, viz., labour, and therefore give misleading results when the relative proportions of the different factors of input are subject to change, e.g., when capital is being substituted for labour. Until a more satisfactory method has been devised, however, it seems likely that comparisons of productivity will continue to be made by means of output per man-hour or per man-year.

In some industries, e.g., coal or iron and steel, this is fairly simple, although the qualifications tend to be overlooked. For the chemical industry it is particularly difficult, for reasons stated in the previous section, and it is noteworthy that Dr. L. Rostas, in his *Comparative Productivity in British and American Industry*, has not included chemicals in the appendix on “International Productivity Comparisons in Individual Manufacturing Industries”. He has, however, given the estimated net output per head of operatives in the United Kingdom, Germany and the U.S.A. in different pre-war years for various industries, including chemicals, for which the figures are as follows:

		£	Index Numbers
United Kingdom	1935	617	100
Germany	1936	651	106
U.S.A.	1937	1,145	186

Reference may be made here to an article on “Business Productivity” in *The Economist* of August 14th, 1948, in which an attempt was made to estimate the change in output per man in various industries between 1935 and 1947. The writer of that article estimated that in the chemical industry output per man had fallen by 27 per cent. between those years. To arrive at this result he had used the London and Cambridge Economic Service’s Index of Production, as the Central Statistical Office had not then given any pre-war comparison for the chemical industry. At that time the London and Cambridge Economic Service gave an index for chemicals of 85 for 1935, taking 1946 as 100. Shortly afterwards, they revised this figure to 76, and added a footnote to the effect that it should not be used in calculations of productivity. Nearly two years later this was further amended to 69 (see above) in the light of the results of the Partial Census of Production for 1946. Had this figure been available at the time, it would have shown a fall of about

1951]

10 per cent. instead of 27 per cent. in output per man between 1935 and 1947. If the official index is taken for both years the fall is only 3 per cent.

It is extremely difficult to make such comparisons between pre-war and post-war years, but there is little doubt that productivity at the present time (1950) is appreciably higher than before the war.

Labour Statistics

Official statistics on numbers employed and unemployed, labour turnover, industrial disputes, wage rates, average weekly earnings and average number of hours worked are published in the *Ministry of Labour Gazette*. The interpretation of these statistics has been fully covered by R. B. Ainsworth in an earlier article in this series (*Journal of the Royal Statistical Society*, Vol. CXIII, Part I).

In the *Gazette* for February, 1949, the estimated number of employees insured under the National Insurance scheme in July, 1948, is shown, together with the estimated number who would have been insurable against unemployment under the old scheme; the wider scope of the National Insurance Acts led to an increase in the number of insured persons in "Chemicals and Allied Trades" from 360,070 to 427,930.

The numbers employed in "Chemicals and Allied Trades" in July, 1950, were as follows:

	Thousands
Coke Ovens and By-Product Works	17·2
Chemicals and Dyes	204·4
Pharmaceutical Preparations, Toilet Preparations, Perfumery	34·1
Explosives and Fireworks	36·1
Paint and Varnish	38·8
Soap, Candles, Glycerine, Polishes, Ink and Matches	49·1
Mineral Oil Refining	36·2
Other Oils, Greases, Glue, etc.	30·7
Total Chemicals and Allied Trades	446·6

The figure for "Chemicals and Allied Trades" returned in the table headed "Analysis of Civil Employment" is slightly larger because it includes employers and persons working on their own account. A more detailed analysis of the population by occupation and industry will be given when the results of the 1951 Census of Population are available. A regional analysis of the number employed in the chemical industry will be found in the annual *Tables Relating to Employment and Unemployment in Great Britain*.

Minimum or standard time rates of wages of manual wage-earners in the chemical industry are given in the Ministry of Labour's publication, *Time Rates of Wages and Hours of Labour*. They are based on agreements made between the employers' organizations and the Trade Unions or by Joint Industrial Councils. The 1949 issue contains rates for "Coke ovens and By-product Works", "Drug and Fine Chemical Manufacture", "Heavy Chemicals Manufacture", "Paint, Varnish and Lacquer Manufacture", "Match Manufacture", "Seed crushing, Compound Food and Provender Manufacture", and "Soap, Candle and Edible Fat Manufacture". In some cases wage rates are given for different occupations; in others only a general minimum rate is stated. Where available, basic rates for piece workers are also included. Changes in wage rates are published every month in the *Ministry of Labour Gazette*. The monthly Index of Wage Rates compiled by the Ministry is not broken down by industries.

Changes in wage rates, however, are not a proper measure of changes in actual earnings, which are affected by overtime, night work, piece work, sickness, etc. Because of this the Ministry has been making inquiries twice a year (in April and October) to obtain details of average weekly earnings and hours worked. When tracing the movements of earnings over a period, allowance must be made for the change in the definitions of the various sections of the chemical industry;

but the new definition of the chemical industry in the Standard Industrial Classification does not invalidate comparison of present average weekly earnings in the industry with earlier figures. In April, 1950, the average weekly earnings of all workers in "Chemicals and Allied Trades" amounted to £6 9s. 2d. as compared with £2 15s. 0d. in October, 1938, and the average number of hours worked was 46.0 as against 47.2. Number of hours worked means hours actually worked and not the normal or standard week given in *Time Rates of Wages and Hours of Labour*. The proportion of workers in the chemical industry paid at piece rates was 13 per cent. in October, 1949, as against 9 per cent. in October, 1938.

Some of the statistics mentioned cover Great Britain only, i.e., excluding Northern Ireland, whilst others cover the whole of the United Kingdom. Employment and unemployment figures apply to Great Britain, but an industrial analysis of unemployment is also given for the United Kingdom. The six-monthly inquiry into the average weekly earnings and hours worked covers the whole of the United Kingdom.

Many of the statistics published in the *Ministry of Labour Gazette* are reproduced in the *Monthly Digest of Statistics* and the *Annual Abstract of Statistics*. For data before 1937 reference should be made to the *Abstract of Labour Statistics*.

Further details relating to employment will be found in the Census of Production. The employment figures given in the Census are not strictly comparable with those published by the Ministry of Labour.

The *A.B.C.M. Report* (Table VIII, p. 71) gives an analysis by number of employees, of 268 companies, comprising the great majority of firms in the chemical industry. This analysis is reproduced here in Table 5. The companies were asked to dissect their labour figures so as to include only the proportion employed in the manufacture of chemicals, so the figures of employees represent not the total employed by the companies concerned, but only the numbers engaged on chemical production.

TABLE 5
*Distribution of Companies in the Chemical Industry at the End of
1948 by Number of Employees*

Number of Employees	Companies		Employees	
	Number	%	Number	%
0-10	31	11.5	206	0.15
11-24	49	18.3	861	0.6
25-99	89	33.2	4,748	3.35
100-499	61	22.8	13,711	9.7
500-999	20	7.5	13,832	9.7
1,000-1,999	12	4.5	17,891	12.6
2,000 and over	6	2.2	90,568	63.9
Total	268	100.0	141,817	100.0

The *Ministry of Labour Gazette* for June, 1950 (p. 190), gives a somewhat similar table for establishments at the end of 1949, excluding those with 10 or fewer employees. By "establishment" is meant an individual works, or in certain cases where a works serves more than one industry, the part of the works that serves the particular industry in question. Table 6 shows the figures for Chemicals and Allied Trades (Order IV of the Standard Industrial Classification), with percentages inserted by the authors of this paper.

The definition of "chemical industry" adopted for the *A.B.C.M. Report* is, as has already been shown, much narrower than Order IV of the Standard Industrial Classification, which mainly accounts for the difference in total numbers employed. It is clear, however, that the distribution of establishments is very different from that of companies, and that the two tables are not really comparable. As the *Ministry of Labour Gazette* points out, "The unit in this scheme of employment returns is the individual establishment. In general, separate returns are required in respect of every distinct establishment, and those firms which have more than one establishment are therefore reported more than once in the figures".

TABLE 6

*Distribution of Establishments in Chemical and Allied Trades by
Number of Employees at the End of 1949*

Numbers of Employees	Establishments		Employees	
	Number	%	Thousands	%
11-24	643	28	11	3
25-99	981	42	49	13
100-499	573	25	121	33
500-999	89	3	61	17
1,000-1,999	28	1	36	10
2,000 and over	23	1	89	24
Total	2,337	100	367	100

One interesting fact that emerges from the *A.B.C.M. Report* is that over 4 per cent. of all employees in the chemical industry (as defined) consists of professionally qualified scientists such as chemists, physicists and engineers.

Prices

The Board of Trade Wholesale Price Index is divided into 11 Groups, one of which is headed "Chemicals and Oils". This Group carries a weight of 15 out of a total of 200 for all articles, including food and tobacco. There are over 30 commodities entering into the index number for "Chemicals and Oils", but their importance varies. A list of them and of the weights attached to them is given below:

	Weight
<i>Chemicals:</i>	
Soda crystals	1
Sulphuric acid	1
Other chemicals: average of 10	1
Fertilizers: average of 3	1
Nitrate of soda	
Sulphate of ammonia	
Superphosphate	
Coal-tar products: average of 5	1
Aniline oil	
Carbolic acid crystals	
Naphthalene	
Nitrobenzene	
Toluole	
Drugs: average of 4	1
Aspirin	
Bromide of potassium	
Phenolphthalein	
Salicylic acid	
Sub-total: Chemicals, 6	
<i>Paint:</i>	
Genuine white lead	1
Fine copal varnish	1
Sub-total: Paints, 2	

	Weight.
<i>Oils and Fats:</i>	
Groundnut oil	1
Palm kernel oil	1
Soap	1
—	
Sub-total: Oils and Fats, 3	
<i>Petroleum:</i>	
Kerosene	1
Lubricating oil	$\frac{1}{2}$
Motor spirit	$1\frac{1}{2}$
Fuel oil	1
—	
Sub-total: Petroleum, 4	
—	
Total Chemicals and Oils, 15	
—	

Chemicals account for less than half the weighting given to this Group; movements in the index cannot therefore be taken as indicative of changes in the wholesale prices of chemicals only. Taking 1938 as 100, the index for "Chemicals and Oils" rose to 201.4 in 1948 and 228.6 in October 1950; the Association of British Chemical Manufacturers, however, has estimated that in 1948 the wholesale price index for "Chemicals only" was only 156.1 (*A.B.C.M. Report*, p. 54).

The wholesale price index numbers published in the *Board of Trade Journal* are calculated on the basis of 1930; in the *Monthly Digest of Statistics* they are converted to 1938 = 100. No comparison can be made with years before 1930, as chemicals were not named in any of the groups into which the old Board of Trade index was divided. Neither *The Statist's* nor *The Economist's* index mentions chemicals as a separate group.

The Ministry of Agriculture and Fisheries compiles an index of fertilizer prices for England and Wales based on 1937/38 = 100. This index is published in the *Monthly Digest of Statistics* and the *Annual Abstract of Statistics*, and consists of the following items:

Sodium nitrate.
"Nitro chalk".
Ammonium sulphate.
Superphosphate.
Basic slag.
Ground rock phosphate.

Exchequer subsidies are included, so that when the subsidy was reduced in July, 1950, the index jumped from 151 to 189.

Another measure of changes in the prices of chemicals is provided by the index numbers of average values derived from the trade returns. This measures the relationship between the total value of goods imported or exported in the current period and the value which the same assortment of goods would have had in 1947. Until recently, however, the base year was 1938. Figures are published quarterly in the *Board of Trade Journal* for each group of goods listed in the Trade and Navigation Accounts. For "Chemicals, Dyes, Drugs and Colours" the 1949 index number of average import values based on 1938 as 100 was 247, and that of average export values 243. These indices, however, do not reflect average price changes in the home trade considering its entirely different composition and quantitative relationships.

Turning from price index numbers to actual wholesale prices, one has to rely almost entirely on trade journals, e.g. the *Chemical Trade Journal*. Before the last war the *Board of Trade Journal* published monthly market prices of some of the commodities on which the price index is based, and the average annual wholesale prices were given in the "Statistical Abstract for the United Kingdom." This practice has unfortunately ceased, and the only chemicals of which prices are still

1951]

officially published (by the Ministry of Agriculture and Fisheries; also quoted in the *Monthly Digest* and the *Annual Abstract of Statistics*) are the six fertilizers mentioned above. Apart from these there are of course still a few chemicals which are price-controlled by statutory instrument.

International Chemical Statistics

Statistics of imports and exports of chemicals are found in the trade returns of most countries; production statistics are less satisfactory, but can often be found in statistical yearbooks or similar publications. The *Statistical Yearbook of the United Nations* gives production for a large number of countries over a period of years of

Sulphuric acid,
Hydrochloric acid,
Nitric acid,
Caustic soda and soda ash,
Nitrogen*,

and various petroleum products.

The Organization for European Economic Co-operation has recently begun to publish, at four-monthly intervals, a "memorandum" entitled "Exportable Surpluses of Chemical Products", printed in French and English. It shows exportable surpluses of a wide range of chemical and allied products, including explosives, plastic materials, etc., as reported by the countries participating.

The Imperial Institute publishes *The Mineral Industry of the British Commonwealth and Foreign Countries*, which gives, for the countries concerned, production, imports and exports of minerals, including Nitrogen Compounds, Petroleum and Allied Products, and various other substances belonging to, or related with, the chemical industry. *The Minerals Yearbook*, published by the United States Bureau of Mines, contains a series of articles on various minerals, with a large number of tables dealing mainly with American statistics, but occasionally giving useful information about world production.

This article is chiefly concerned with British statistics, but a brief account must now be given of American chemical statistics for purposes of comparison.

TABLE 7

U.S. Imports for Consumption, Group 8 (Chemicals and Related Products)—1949

<i>Tariff No.</i>	<i>Product</i>	<i>Value (\$'000)</i>
8000000	Dead or Creosote Oil	5,493
8050200	Coal-tar colors, dyes, stains, etc.	2,225
8127100	Menthol, natural	2,707
8290000	Glycerine, crude	3,235
8339000	Sodium cyanide	2,906
8380950	Other chemical compounds, etc., not containing alcohol, n.c.s.	2,699
8500000	Ammonium sulphate	4,894
8501500	Ammonium nitrate mixture, over 20 per cent. Nitrogen.	8,096
8502000	Calcium cyanamide	5,590
8506000	Sodium nitrate	26,006
8509000	Ammonium phosphate for fertilizers	7,543
8559400	Peat moss, fertilizer grade	2,213
	Other products	33,157
	Group total	106,764

* Nitrogen content of nitrogenous fertilizer.

U.S. Chemical Statistics

(N.B.—American spelling has been retained where appropriate).

Any detailed discussion of American trade statistics would be out of place here, but in view of their importance the principal imports and exports of Chemicals and Related Products in 1949 are summarized in Tables 7 and 8. The data are taken from Reports Nos. FT 110 and 410, "United States Imports of Merchandise for Consumption" and "United States Exports of Domestic and Foreign Merchandise" for 1949.

TABLE 8

U.S. Exports of Domestic Merchandise, Group 8 (Chemicals and Related Products)—1949

<i>Tariff No.</i>	<i>Product</i>	<i>Value (\$'000)</i>
805909	Coal-tar dyes, n.e.s.	43,302
811990	Vitamin preparations in dosage form	16,888
813576	Penicillin	39,742
813577	Streptomycin	40,026
820590	Agricultural insecticides, n.e.s.	12,277
825410	Vinyl vinylidene chloride	12,057
829910	Antiknock compounds not of petroleum origin.	22,715
832990	Organic chemicals not of coal-tar origin	18,020
837310	Sodium hydroxide, solid	11,853
842310	Carbon black, contact	19,840
843800	Ready mixed paints, stains and enamels	15,953
850500	Ammonium sulphate	28,752
850800	Ammonium nitrate, fertilizer	30,190
	Other products	462,451
Group total		774,066

These tables show very clearly how much greater and more diverse exports are than imports. It is interesting to compare the American "Group 8" with our own "Class III, Group O". Group 8 includes soap, explosives and ammunition, plastics (except synthetic rubber), and both natural and synthetic fertilizers. The American trade statistics are given in far more detail than the British.

Turning to chemical production, the Report on the Census of Manufactures 1947, Vol. II, *Statistics by Industry*, devotes 65 pages to Chemicals and Allied Products covering

Industrial Inorganic Chemicals.
 Industrial Organic Chemicals.
 Drugs and Medicines.
 Soap, Glycerin, Cleaning, Polishing and Related Products.
 Paints, Varnishes, Pigments and Allied Products.
 Gum and Wood Chemicals; Fertilizers.
 Vegetable and Animal Oils.
 Miscellaneous Chemical Products.

The United States Department of Commerce publishes a monthly *Survey of Current Business*, which gives production figures for a considerable number of inorganic chemicals, organic chemicals and fertilizers, and the 1949 *Statistical Supplement* shows the same information for each year from 1936 to 1944 and monthly from 1945 to 1948. *Synthetic Organic Chemicals, United States Production and Sales*, an annual publication of the United States Tariff Commission, gives production and sales of a great variety of crude organic chemicals, intermediates, and finished products, e.g. dyes, medicinals, plastics, etc. "Facts for Industry" leaflets, published by the Bureau of the Census, give production figures each month for a wide range of commodities. Then

1951]

there is *Chemicals and Drugs, Industry Report*, published monthly by the United States Department of Commerce, which gives a considerable amount of trade and production statistics.

The *Federal Reserve Bulletin* publishes an Index of Industrial Production, adjusted for seasonal variation, one of the groups being "Chemicals and Allied Products". This is divided into five sub-groups, the following weights being allotted to them out of a total of 100 for all commodities:

Paints	0.78
Soap	0.45
Rayon	0.60
Industrial chemicals	1.71
Explosives and others	2.73
<hr/>	
Total Chemicals and Allied Products	6.27

Petroleum and Coal Products form a separate group with a weight of 2.14.

The Department of Labor, Bureau of Labor Statistics, publishes statistics on factory employment and payroll indices, average hourly and weekly earnings, average hours worked per week, estimated number of wage earners, strike statistics and labour turnover data. For classification purposes the heading "Chemicals and Allied Products" is used, consisting of the following 10 Sections:

- Chemicals, not elsewhere specified.
- Compressed and liquefied gases.
- Rayon and allied products.
- Fertilizers.
- Cotton seed oil, cake, meal, etc.
- Ammunition, small arms.
- Explosives and safety fuses.
- Soaps.
- Drugs, medicines and insecticides.
- Paints, varnishes and colors.

This classification differs in several important respects from its British counterpart; e.g., it includes rayon and allied products but excludes mineral oil refining. It is therefore not possible to make a straight comparison between employment figures of the two countries in the chemical industry.

Wholesale prices are given for hundreds of chemicals in a weekly trade journal, *The Oil, Paint and Drug Reporter*. The Bureau of Labor Statistics also publishes a Wholesale Price Index, based on 1926 and going back to 1890. One of the component groups is headed "Chemicals and Allied Products", and separate indices are compiled for each of the following sub-groups:

- Drugs and pharmaceuticals.
- Chemicals.
- Fertilizer materials.
- Mixed fertilizers.
- Oils and fats.

There is, of course, much duplication of information in the sources mentioned above and in the various trade journals, but in many cases it would be impossible to find similar figures for the United Kingdom even once. This country has nothing corresponding to *Chemical Facts and Figures*, a volume of about 400 pages, published by the Manufacturing Chemists' Association of the United States, giving a mass of information on production, sales, imports, exports and wholesale prices of chemicals and related products. In fairness, however, it should be said that the second edition, published in 1946, is the latest available at the time of writing, although it is understood that a third edition will be published shortly.

Conclusion

The Chemical Industry is a relatively young industry; it is technologically progressive, with a highly diversified and constantly changing range of products. This will occasionally call for

revision of existing classifications and affect the comparability of data over a period of years. Furthermore, with entirely new branches of chemistry being grafted on to existing knowledge—*vide* recent developments in the field of insecticides, weed-killers, antibiotics, petroleum chemicals, synthetic fibres, etc.—the balance between the different sections of the industry is gradually changing. The continuous venture into unknown territory and the dependence on research and development tend to give the chemical industry a dynamic character which the older, long-established industries lack. Statistics which can only compare like with like are thus a somewhat imperfect tool for measuring the industry's long-term progress.

Bibliography

This bibliography is confined to British publications, but a large number of American sources are mentioned in the latter part of the paper.

1. For Current or Recent Data

Monthly Digest of Statistics.

Annual Abstract of Statistics.

Accounts Relating to Trade and Navigation of the United Kingdom (monthly).

Annual Statement of the Trade of the United Kingdom.

Report on Overseas Trade (monthly).

Ministry of Labour Gazette (monthly).

Board of Trade Journal (weekly).

Tables Relating to Employment and Unemployment in Great Britain (annual).

Ministry of Fuel and Power Statistical Digest (irregular).

Bulletin of the British Bureau of Non-Ferrous Metal Statistics (monthly).

Bulletin of the London and Cambridge Economic Service (quarterly).

Chemical Trade Journal (weekly).

The Mineral Industry of the British Commonwealth and Foreign Countries (annual).

2. For Pre-War Data

Statistical Abstract of the United Kingdom (annual).

Abstract of Labour Statistics (irregular).

Reports on the Censuses of Production and Import Duties Act Inquiries 1907–1935.

3. Other Publications

Standard Industrial Classification, 1948.

Report on the Chemical Industry 1949 (Association of British Chemical Manufacturers).

Carter, Reddaway and Stone, *The Measurement of Production Movements*. Cambridge University Press, 1948.

Rostas, *Comparative Productivity in British and American Industry*. Cambridge University Press, 1948.

Partial Census of Production, 1946, "Preliminary Report on Chemicals, Dyestuffs, and Drugs Trade,"

Board of Trade J., 154 (1948).

"Business Productivity", *Economist*, 155 (1948), 273.

1951]

REVIEWS OF STATISTICAL AND ECONOMIC BOOKS

CONTENTS

	PAGE
1.—Feller (W.). Introduction to Probability Theory and its App'ications. Vol. I .	249
2.—Wald (A.). Statistical Decision Functions	250
3.—Johnson (N. L.) and Tetley (H.). Statistics. Vol. II	253
4.—Quenouille (M. H.). Introductory Statistics	254
5.—Beer (E. J. de). (Ed.) The Place of Statistical Methods in Biological and Chemical Experimentation	255
6.—Schrock (E. M.). Quality Control and Statistical Methods	255
7.—National Bureau of Standards. Tables of the Binomial Probability Distribution	256
8.—American Statistical Association. Acceptance Sampling	257
9.—Cox (P. R.). Demography	257
10.—United Nations. Population Census Methods	258
11.—Economic Commission for Europe. Annual Bulletin of Transport Statistics .	260
12.—Tinbergen (J.). The Dynamics of Business Cycles	260
13.—Abramowitz (M.). Inventories and Business Cycles	261
14.—Miller (D. C.). Taxes, the Public Debt and Transfers of Income	263
15.—Crew (A.). Economics for Commercial Students and Business Men. 13th ed. .	265
16.—Clark (Colin). The Conditions of Economic Progress. 2nd ed.	265
17.—Devons (E.). Planning in Practice	266

1.—*An Introduction to Probability Theory and its Applications*. Vol. I. By William Feller. New York: John Wiley (London: Chapman & Hall) 1950. xii + 419 pp. 9½". \$6.00.

This is an extremely important book, which will exercise a profound influence on the development of the subject. The author, who is now Professor of Mathematics at Princeton (though the book was written while he was still at Cornell), enjoys an international reputation for his work on the analytical theory of probability, and he has also taken an active part in the development of many of the applications. He explains in the preface that his original intention was to write a treatise on analytical methods in probability theory in which the latter was to be treated as a topic in pure mathematics, but he was persuaded by the United States Office of Naval Research to attempt the much more difficult task of writing a book which would be of equal value to the mathematician interested in the rigorous theory, and to the biologist, engineer or physicist looking only for models and techniques of value in his special field. The result is an unqualified success.

In the first few chapters the classical combinatorial problems are discussed in a unified manner and illustrated with a wide variety of topical examples. The author then gives an account of the Poisson and binomial distributions and the de Moivre-Laplace limit theorem, careful attention being given to the size of the remainder-term. An important chapter follows in which the *strong* law of large numbers and the law of the iterated logarithm for Bernoulli trials are explained and then proved. These topics are further developed in Chapter X, which also contains an account of Feller's solution to the problem of the Petersburg "paradox" and of his theory of "fair" games.

Chapter XI develops in a systematic way the general theory of probability-generating functions. In this first volume Feller is concerned only with discrete random variables, and accordingly the general theory of distribution and characteristic functions has been reserved for the second volume. The advantage of this procedure is that the beginner is able to meet and appreciate many of the most recent advances in the subject in a relatively elementary context.

The remaining half of the book is devoted to Feller's new theory* of "recurrent events", with the aid of which he presents a complete and most elegant account of the properties of Markov chains having a finite or an enumerably infinite number of states. His methods lead to simplifications even when the number of states is finite, and they make it possible to discuss finite and (enumerably) infinite chains with equal ease.

* First presented in his paper "Fluctuation theory of recurrent events", *Trans. American Math. Soc.* 67 (1949), 98-119.

Other topics discussed with the aid of the theory of recurrent events are : the "arc-sine law", success-runs, industrial renewal, the branching processes of population theory, the gambler's ruin and the random walk (the account of which includes a proof of the astonishing theorem of Pólya*).

Chapter XVI contains a detailed algebraic treatment of finite Markov chains, and in the final chapter of the first volume Feller gives a valuable survey of the simplest stochastic processes defined for continuous "time" (birth-and-death processes, congestion processes, machine-servicing problems and so on).

The idea of a *recurrent event* (which is related to Palm's concept† of a *Gleichgewichtspunkt*, further developed by Bartlett and myself‡ under the name of a *regeneration-point*) seems destined to play an important rôle in stochastic process theory. Feller has made clear its fundamental importance in the analysis of Markov chains, while Palm, Bartlett and I have stressed the value of the concept in suggesting methods of dealing with many non-Markovian processes. Very crudely one can say that a recurrent event marks an epoch (a regeneration point) at which the process "forgets its past history and begins its (stochastic) development all over again". In a recent paper§ on animal population dynamics, Moran speaks of "a point in the cycle across which the hysteresis is assumed to be negligible", and this suggests another useful form of words which describes very much the same situation.

Feller's theory of recurrent events is based on a new Tauberian theorem about power-series with positive coefficients which was proved jointly by Erdős, Feller and Pollard.|| Power-series theorems have been applied in this field before; thus Yosida and Kakutani¶ obtained the (C,1) limit theorem for Markov chains with the aid of the Hardy-Littlewood-Karamata theorem. The Erdős-Feller-Pollard theorem makes it possible to discuss the periodic phenomena which are smoothed out by the (C,1) process, and it leads to such valuable criteria as the following: *if P is the matrix of one-step transition-probabilities and if all of its diagonal elements are positive** then the chain is "aperiodic" and*

$$\lim_{n \rightarrow \infty} P^n$$

exists in the ordinary sense. (In general it can only be asserted that this limit exists in the (C,1) sense.)

The power-series theorem is relatively a "deep" one, and the proof is at first a little difficult to comprehend. It would be helpful if this section (§12.7) were expanded in the second edition. The book is likely to stimulate research to such an extent that one will soon be needed.

DAVID G. KENDALL.

2.—*Statistical Decision Functions.* By Abraham Wald. New York: John Wiley & Sons, Inc. (London: Chapman & Hall, Ltd.), 1950. ix + 179 pp. 9". \$5.00.

In this most interesting book Professor Wald has for his object a formulation and solution of what Professor Neyman has called the problem of inductive behaviour. Given a set of random variables, a set of possible probability distributions of these variables and a sample of them obtained according to an unknown probability distribution belonging to the set, the problem of inductive behaviour is to make statements about the unknown distribution on the evidence of the sample. The formulation of the problem considered in this book is general, and includes not only statements about the distribution, but general decisions that might be made on the knowledge provided by the sample. Another new feature, claimed by the author as a "major advance", is the inclusion in the problem of decisions about what samples shall be taken in order to improve this final decision; as, for example, whether a sequential or fixed sample size method shall be used. The former are called decisions on experimentation as distinct from the latter, which are called terminal decisions. A decision function is a function of the sample values giving the rules

* G. Pólya, "Über eine Aufgabe der Wahrscheinlichkeitsrechnung betreffend die Irrfahrt im Strassen-netz", *Math. Ann.*, 84 (1921), 149-60.

† C. Palm, "Intensitätsschwankungen im Fernsprechverkehr", *Ericsson Technics*, No. 44 (1943), 1-189.

‡ M. S. Bartlett and D. G. Kendall, "On the use of the characteristic functional in the analysis of some stochastic processes occurring in physics and biology", *Proc. Cambridge Phil. Soc.*, 47 (1951), 65-76. (Further applications of the same group of ideas will be found in my forthcoming paper, "Some problems in the theory of queues", to appear in Series B of this *Journal*.)

§ P. A. P. Moran, "Some remarks on animal population dynamics", *Biometrics*, 6 (1950), 250-8.

|| P. Erdős, W. Feller and H. Pollard, "A property of power series with positive coefficients", *Bull. American Math. Soc.*, 55 (1949), 201-4.

¶ K. Yosida and S. Kakutani, "Markoff process with an enumerable infinite number of possible states", *Japanese Jour. of Maths.*, 16 (1940), 47-55.

** This simple condition is sufficient but not necessary.

1951]

for the experimentation and the terminal decision. In order to judge the merit of any decision function the concepts of a weight function $W(F, d)$ measuring the loss suffered by making a terminal decision d when the probability distribution is F , a function giving the cost of experimentation and, where relevant, an *a priori* distribution of the possible probability distributions, are introduced. Using these ideas a solution to the problem is suggested, and a large part of the book is taken up with the task of establishing the existence of the proposed solution.

There are five chapters to the book. The first gives the complete formulation of the problem, introduces the notion of average risk, $r(F, \delta)$ when the true distribution is F and the decision function δ is used, and defines the minimax solution, which is that decision function which minimizes the maximum average risk for any *a priori* distribution; this solution enables the problem to be interpreted as a zero-sum two-person game in the sense of von Neumann. The second chapter contains some extensions of von Neumann's results in the theory of games, and in the third chapter these extensions are used to give a general development of the theory. In the fourth chapter the theory is more fully developed in the case where the random variables are independently and identically distributed and the cost of experimentation is proportional to the number of observations. The final chapter deals with applications of the theory to special cases. There is a full bibliography and a good index.

In order to examine the theory of statistical decision functions it is convenient to recognize three aspects of Professor Wald's treatment: Firstly there is the formulation of the problem of decisions, both experimental and terminal, and the introduction of weight and cost functions. Secondly, there are the notions of average loss and average cost, which are combined to give the concept of average risk $r(F, \delta)$; and the introduction of complete classes of decision functions and of Bayes solutions. Finally there is the introduction of the minimax solution, mentioned above, as the "best" solution of the problem. It seems to me that these three divisions are worth making because their respective values from the point of view of their importance in statistical theory are widely different.

Let us consider the last of these notions, the minimax solution, first, because it is the easiest to discuss. The general adoption of this method of inference would amount to acting as if one lived in the worst of all possible worlds. Even for an American, this would seem an unnecessarily harsh assumption. It is a reasonable assumption in the theory of games, where one is entitled to assume one's opponent is doing his best to win, and therefore from one's own point of view the worst is happening; but it is not so sensible here where one's opponent is "Nature". Surely she is not so harsh a task-mistress as this? It is not, however, fair to say that therefore the minimax solution is valueless. It has rightly been described as a conservative method, presumably because it does give an upper limit to the average risk that will be incurred, and this limit is the lowest possible. It does not guarantee that the actual risk is anywhere near this limit: though in certain rather special circumstances it can be shown (p. 128) that the minimax solution is that one which makes the average risks, for every possible probability distribution, the same. This may sometimes be of value, though it is easy to construct cases where it is not.

The formulation of the decision problem given at the beginning of the book is excellent. The argument is very clearly developed and the result is a clarification of the whole problem. The treatment is sufficiently general to apply to almost every situation and, as mentioned above, includes the actual design of the experiment as well as the interpretation of the experimental results. In previous work of the author the introduction of a randomized decision, that is a decision based on the sample values and on additional material obtained from some other known random mechanism, has seemed artificial. No experimenter would be prepared to use such a method, except in the case of boundary values in dealing with discrete variables (*vide* Tocher, *Biometrika*, 37, (1950), 130), and if the minimax method produced a randomized decision function in any situation of the type already examined it would be a strong *a posteriori* reason for rejecting the method.* However, these remarks apply to terminal decisions; experimental decisions can be random without offending one's instinctive ideas, as Professor Fisher has shown. Unfortunately Professor Wald does not show that the minimax method of designing any experiment produces a design of Fisher's type, but it seems reasonable to suppose it might. On these grounds the introduction of randomized decisions may be of value in the general theory. The introduction of weight and cost functions and, where relevant, *a priori* distributions is also valuable, and no theory of inference should exclude mention of these ideas: the first is much to be preferred to the two types of errors of the Neyman-Pearson theory. There is, though, a difficulty in the weight function notion. If a mathematical model is to be constructed, as it is here, then it ought to be clear what it is that the numerical values of the functions used correspond to in the real

* NOTE.—Since this review was written a paper has appeared (Dvoretzky *et alia*, (1951), *Ann. Math. Statist.*, 22, 1) in which the authors show, that in a large class of cases where the distributions are continuous, randomization is unnecessary.

world. Probability corresponds to frequency, but what is it that the weight function corresponds to? If everything is in monetary terms then the treatment is clear, but the majority of situations do not permit one to judge the cost of mistakes in these terms. The difficulty can, I think, be avoided by the considerations advanced below.

Having formulated the problem Professor Wald turns his attention to its solution, and introduces the notions that I have mentioned in the second aspect of his work. Without any remark more than "it seems reasonable to judge the merit of any given decision function for the purposes of inductive behaviour entirely on the basis of the [average] risk function associated with it", the function is used to provide a basis for the solution. This would seem highly questionable. The use of the average alone cannot have the same generality that the formulation of the problem has because it replaces a function by a single number. One risk function may have a smaller variability at the cost of a higher average than another and be preferred on that account, or because the latter may occasionally result in the occurrence of a large loss. Another difficulty caused by the introduction of the risk function is that as it is the sum of the average loss in making a terminal decision and the average cost in using a decision of experimentation, the cost function and loss function must be measured on the same scale. Whilst it is often possible to assess the relative losses incurred by different decisions, it may be very difficult to assess the actual loss in terms of the cost of experimentation. It leads to the assessment of weight functions in monetary terms mentioned above.

From the notion of average risk $r(F, \delta)$, another averaging process is carried out. This is with respect to an *a priori* distribution ξ in the set of probability distributions, F , and yields

$$r^*(\xi, \delta) = \int r(F, \delta) d\xi.$$

A Bayes solution is then a decision function which minimizes this quantity for a given *a priori* distribution. The Bayes solutions are shown, under general circumstances, to have the property of completeness. A class C of decision functions is said to be complete if for any δ not in C there is a δ' in C such that

$$r(F, \delta') \leq r(F, \delta) \quad \dots \dots \dots (1)$$

for all F , and the strict inequality holds for some F . Even if we regard the minimax concept as stillborn these ideas are of importance, because they show that when we base our decisions on average risks then we need not search outside the class of Bayes solutions for our decision function. It is not shown that this class is the smallest complete class, but in many situations it will be. The idea of completeness, apart from average risk, is of even greater value, because it can be expressed in terms of any partial ordering relation in place of (1): the concept is due to Lehmann. As an example of an approach which is to me more hopeful than that based on risk consider the following situation: Suppose there are a finite number of possible probability distributions F_i , the only terminal decisions are that the true distribution is F_i , and the unique decision of experimentation to take a sample of size n . That is we have a point estimation problem of fixed sample size. Then any decision function defines a matrix (p_{ij}) , where p_{ij} is the probability of making the i th decision when the j th distribution holds. Two decision functions with the same matrix may be regarded as equivalent. Completeness can now be defined by replacing (1) by $p'_{ij} \leq p_{ij}$ for all unequal i and j and the strict inequality holds for some pair of different suffixes. Then a complete class is the class of decompositions of the sample space whose boundaries are linear functions of the likelihoods. This approach is free from the difficulties of the average risk concept. Also the use of the matrix technique avoids the difficulties of interpretation of the weight function mentioned above because it is known what the statement $p_{ij} = \frac{1}{4}$, say, means in the real world, namely, that in the long run if F_j is true this mistake will be made one quarter of the time.

The major part of the book is severely mathematical. Professor Wald does not shirk the manipulation of very complicated formulae and pushes his way forward with great persistence. I have the feeling that a less industrious but equally intelligent person might have achieved a simpler presentation. For example, much of the argument has to be repeated twice over, once in the discrete variable case and once in the absolutely continuous variable case. Now there is no essential difference between these two cases, and therefore one might have expected a common mathematical treatment instead of quite distinct ones, as for example in the types of convergence in the space of decision functions (3.1.4). In fact such an approach is possible along the following lines. Let Ω be the class of probability distributions ω considered and let $p_\omega(A)$ be the probability of the Borel set A according to the distribution ω . If ω and ω' are two members of Ω and if there exists a set A for which $p_\omega(A) = 0$ and $p_{\omega'}(A) \neq 0$, then clearly if a sample value falls in A the true distribution is not ω but possibly ω' . It is therefore sufficient to consider the case where

1951]

for every pair of distributions ω, ω' , $p_\omega(A) = 0$ implies $p_{\omega'}(A) = 0$. Such distributions are termed absolutely continuous with respect to one another. This situation covers the discrete case of Wald, the most important part of his absolutely continuous case and some cases not considered by him. (I have a suspicion that the cumbersome definition of convergence used in this latter case is necessitated by his definition of the absolutely continuous case.) There is another advantage in considering this situation because, by the Radon-Nikodym theorem, the absolute continuity of two measures ensures the existence of their likelihood ratio, which is the common basis for making decisions in almost everybody's inferential method: for example, Neyman-Pearson's, Jeffreys', Fisher's and even, it turns out, Professor Wald's.

Another feature of the mathematical treatment is the character of many of the results obtained. When, after a long argument, the theorem is stated and proved, one has the same feeling as one had when one first tackled the Jordan curve theorem: "Well, of course, it is true; isn't it obvious?" The Jordan curve theorem is not obvious and does need the difficult proof. So probably do Wald's theorems, but I cannot help feeling that it would have been better to have worked the other way round, namely, from the particular to the general. The existence theorems could have been left until special cases had been examined and the practical meaning of the ideas appreciated. The general theory would have been valuable if it had suggested powerful new tools, but it does not seem to me that many have emerged, though it will need time for the consequences of many of the mathematical ideas to emerge. It is certain, however, that the average statistician will make little headway with the methods of proof despite the assurances in the preface. Furthermore, although the treatment has the appearance of great generality, when particular situations are considered it is seen that apparently very slight topological assumptions are not satisfied: e.g., the requirement that parameter space be bounded is artificial. Also reasons similar to those which necessitate allowing the cost function to be infinite would apply to making the weight function infinite, but in fact it is assumed bounded.

Gauss had on his seal the motto *Pauca sed matura*. We have come a long way since then, and to-day most workers are so keen to publish that the appropriate motto might be *Multa sed cruda*. The defect caused by early publication is apparent in this book: it has not the completeness and unity one might have hoped for. But on the credit side it must be said that the publication of this and similar works is to be encouraged because the author's very stimulating ideas can spread more rapidly and easily, and in other minds may attain greater development than they would have done in his own. When, as here, the material merits it, it is better to publish rapidly and incompletely rather than slowly and nearly perfectly. In this case the author's untimely death has shown another reason for publication in book form.

Despite its faults this book ought to be read by all statisticians who wish to think clearly about their subject. In view of the difficulties likely to be encountered it might be helpful to give a plan for reading. I would suggest reading the excellent chapter one first, possibly more than once. Allow to simmer for a few days and then dip into chapter five, and to a lesser degree chapter four. The remaining two chapters are perhaps best only skimmed, except for the *rara avis* who is prepared to meet four different topologies on the same page.

The printing and proof-reading are very good. A minor criticism is that I should have liked to have seen more variety in the type, and more space between the lines.

D. V. LINDLEY.

3.—*Statistics: An intermediate text-book*. Vol. II. By N. L. Johnson and H. Tetley. Cambridge University Press, 1950. xi + 380 pp. 8½". 20s.

This is the second and last volume of a work of which the first volume has already been reviewed in this *Journal*. It makes a determined plunge into more scientific statistics than that which based all tests on the normal distribution, and it is, in fact, a splendid text-book of those subjects the authors chose to deal with. Their selection of topics shows unmistakable symptoms of adherence to a well-defined "school". After three chapters on the handling of distribution functions there follows Chapter 14, "General Theory of Statistical Tests and Estimation", giving a very good account of typical regions, kinds of error, power function, simple and composite hypotheses, and even of the determination of most powerful tests by likelihood ratios. After this, estimation is treated rather cavalierly; efficiency and consistency, for instance, are not even mentioned.

The following chapter deals with "Stratified Populations and the Analysis of Variance", showing comparisons of various types of sampling, but of Analysis of Variance only a very elementary stage (in spite of its applications in actuarial literature, which seem to have escaped the authors' notice). The chapter "Correlation Analysis" contains, besides the traditional contents, a section on rank correlation, and the last chapter, "Curve Fitting and Graduation", reverts to a subject dear to every actuary's heart, making use of the critical background which the reader ought by then to have

acquired. The chi-squared test appears in its glory, and makes the reader wonder—unjustly, be it said—what was really the use of Chapter 14.

The general reader, however, for whom this review is written, will gladly note the uncanny skill with which the authors clarify difficulties almost before they are realized, making the subject appear plain common sense, which, after all, it is. The marking of chapters as “of more than usual difficulty” may be helpful, but the reviewer found the frequent apologies that “the reader may find it rather tedious” (p. 162) and similar remarks somewhat irritating. Many exercises are given at the end of chapters and of the book. They contain also the only reference to sequential methods (ex. 14.6 and 14.7).

A few slips may be mentioned in a spirit of helpfulness: the Gamma-function is not mentioned on p. 5, in spite of what the Index says; a remark on p. 18 forgets that probabilities must add up to unity; appendix 6 advises the reader “to read one or more of the text-books mentioned at the end of Chapter 11” but only one appears in that list. More seriously, in example 17.6 (p. 229) it is stated that the degrees of freedom are reduced by 5, since moments were used for finding the parameters. But only linear constraints reduce degrees of freedom in this simple way. (A similarly vague statement appears on p. 90. The general problem is correctly mentioned on p. 236.)

The style of the book is happily fluent. The reviewer liked particularly the remark about refined methods, which “should not be used wastefully to demonstrate the obvious in an apparently obscure manner” (p. 131). The authors are not guilty of such misdemeanour. They have produced a useful addition to our literature, and this volume may very well rank as a standard work on that part of our subject which it presents. S. VAJDA.

4.—*Introductory Statistics*. By M. H. Quenouille. London: Butterworth-Springer, 1950. xii + 248 pp. 10". 30s.

Since R. A. Fisher's *Statistical Methods for Research Workers* first appeared, a considerable number of other books have been written which, covering very roughly the same ground, are intended by their authors either to be easier than Professor Fisher's or to be more suitable to the needs of some class of readers. Mr. Quenouille's is the latest such book. The topics of the nine chapters are: 1, Presentation of Sets of Measurements (the ideas of parent population and estimation being introduced); 2, Normal Distribution (and also the binomial and Poisson distributions); 3, Comparison of Two Sets of Measurements (variance ratio and *t* tests); 4, Comparison of Several Sets of Measurements (including an account of orthogonality, randomized blocks, Latin squares, and factorial designs); 5, Attributes and Comparison of Proportions (contingency tables); 6, Interrelations of Sets of Measurements (regression and correlation); 7, Concomitant Observations (analysis of covariance, and some special uses of this in analysing non-orthogonal designs); 8, Transformations and Non-normal Distributions (transformations to equalize variances, to achieve normality, and for other special purposes; tests for homogeneity, normality and independence); 9, Sampling Methods (for surveys). There is a comprehensive set of Tables at the end, of which the less usual are tables of $\sin^{-1}\sqrt{x}$ and $\sinh^{-1}\sqrt{x}$, and a table of squares and square-roots of integers up to 1,000. The book is intended for workers in any of the fields where modern statistical methods are needed. Little mathematical knowledge is presupposed, and each chapter is divided into two parts, of which the second is more specialized than the first and can be omitted at a first reading. The book is pleasantly produced.

The choice of material and the balance in its presentation are excellent, and obviously result from the author's extensive experience of statistical work in many fields. This is not a mere hash of other books, but is a fresh attempt to meet a need still unsatisfied. The particular glory of the book is its splendid profusion of examples, relating to animal nutrition, medicine, forestry, fishing, agriculture, economics, astronomy, and many other subjects. All responsible for teaching statistical methods will find the book helpful and stimulating.

Unfortunately these virtues are offset by a defect. Written, one supposes, in too great haste, the text often seems to be an exercise in what S. Potter would call authormanship. Subtle and difficult ideas are given scant explanation (as, for example, the concept of an imaginary parent population in Chapter 1); new considerations are introduced by a disarming “It should be remembered that” or “It should be noted that”, as if the reader were already familiar with them; and the wording is often inefficient and careless, and therefore wrong, and therefore difficult to understand. Intelligent readers not already familiar with the subject will find much to puzzle and irritate them. Occasionally the author's views seem to be ill-founded (as in his discussion of systematic sampling in section 9.6). It is to be hoped that, before the book goes into a second edition, the author may be persuaded to spend a year in completely rewriting it, at about twice its present length, so that what needs to be said is said accurately and explicitly. The effort would be abundantly worth while. F. J. ANSCOMBE.

1951]

5.—*The Place of Statistical Methods in Biological and Chemical Experimentation*. Ed. by E. J. de Beer. *Annals of the New York Academy of Sciences*, Vol. 52, 1950. Pp. 789–842. 9½". \$2.75.

The recent spate of symposia, appearing on both sides of the Atlantic, has made clear the characteristic defects and advantages of this method of describing a particular field of scientific activity. On the one hand, the component papers tend to overlap in subject-matter or to assume different levels of preliminary knowledge, and the whole collection is likely to lack perspective and balance. On the other hand, the variety of outlook and approach gives the collection a certain vitality, just as the discussions following scientific papers are frequently more interesting than the papers themselves. The monograph under review is the record of the proceedings at a conference held jointly by the Section of Biology of the New York Academy of Sciences, the Biometric Society, and the New York Metropolitan Chapter of the American Statistical Association, on January 28th and 29th, 1949. That the defects of the symposium method are largely absent, while the advantages are so apparent, is presumably due to the careful editing of L. C. Miller, J. W. Tukey, and the chairman, E. J. de Beer.

The articles fall into four sections. In the first section G. W. Snedecor discusses statistics as a fundamental part of the scientific method; G. M. Cox discusses and illustrates the function of designs in experiments (perhaps rather too large a subject to be confined within 8 pages); and F. Wilcoxon contributes an excellent paper on rapid statistical procedures, in particular those based on ranking methods. The five papers in the second section describe applications of statistical methods to particular scientific fields. W. J. Youden applies the analysis of variance to some published data on the atomic weight of iodine; K. A. Brownlee gives an admirable account of confounding in a factorial experiment on penicillin production; R. A. Harte describes the analysis of certain experiments in nutrition research; C. V. Winder's article on some applications to pharmacology is notable for a penetrating comparison of the suitability for analysis of various scales of measurement, but occasionally assumes some familiarity with pharmacological concepts; H. C. Batson discusses the design and analysis of experiments in experimental immunology in which mice are immunized with different doses of vaccine and then attacked by a "challenge" dose of organisms.

The third section, on biological assay, is introduced by an excellent expository article by C. I. Bliss. L. F. Knudsen discusses microbiological assays, in which the response may be linearly related to the logarithm of the dose (as in plate assays for penicillin) or to the dose itself (so-called slope-ratio assays). There is a valuable survey of various methods of analysing quantal response data by L. C. Miller; the author appears to me to have over-estimated the complexity, and consequently under-estimated the value, of W. R. Thompson's moving average method for estimating the LD 50. B. J. Vos describes briefly his design for graded response assays in which the sensitivity of the experimental material is changing throughout the experiment. The fourth section, dealing with problems involving human populations, is introduced by D. Mainland, who stresses the difficulties peculiar to experiments in the human field. These are enlarged on by D. D. Reid, who describes the recent clinical trials of streptomycin in pulmonary tuberculosis organized by the (British) Medical Research Council. Finally H. M. C. Luykx discusses the definition of a mortality rate.

This publication provides a fascinating illustration of the range and power of modern statistical methodology. It is noteworthy, however, that apart from the three general papers in the first section, only two (Youden's and Brownlee's) deal with chemical applications. The title suggests that one of the purposes of the conference was to spread the gospel amongst the chemical readers of the *Annals*; we may hope that such missionary zeal has been amply rewarded. P. ARMITAGE.

6.—*Quality Control and Statistical Methods*. By Edward M. Schrock. New York: Reinhold Publishing Corporation, 1950. xi + 213 pp. 9". \$5.00.

This book gives an elementary treatment of the Quality Control Chart applied to mass production processes, and is "intended for those who are new (or relatively so) to the field." The case for quality control is well presented in the introductory chapters, and the methods are illustrated throughout the book by practical examples. The various aspects of quality control which are dealt with are: control charts for variables and fraction defective; use of limit gauges; acceptance sampling, including single, double and sequential sampling schemes for fraction defectives. The "Statistical Methods" part of the book is confined to short discussions of distributions, including the Binomial and the Poisson; standard deviation; tests of significance; correlation and linear regression. A short glossary of technical terms, suggestions for further reading and an index are appended.

The practical instructions given for the construction and operation of the control charts and acceptance sampling schemes are adequate if the reader is prepared to accept their statistical basis.

The subject-matter is written clearly and is subdivided into compact paragraphs with well-chosen subtitles, but sometimes trivial matters are included and there is a tendency to explain the obvious.

The author recommends the use of the $\pm 3 \times$ standard deviation limits in all cases, whether the quality is measured by a variable or expressed as a fraction defective. Since the distributions of the range and of the fraction defective are skew to an extent depending on the size of the sample, the degree of control represented by the chance of detecting assignable causes will vary from one chart to another. This may be marked when the number of defects or defectives in routine samples is small.

Copious tables covering over 50 pages are given to assist in the derivation of the control limits for fraction defectives. These tables are over elaborated; all the information required is adequately contained in the first three pages of the tables and in the two graphs supplied. Fifty pages of these tables could have been omitted without loss and more space profitably given to Quality Control by Limit Gauging, including a more detailed discussion of the efficiency of gauging compared with other methods of measurement. In the sections on acceptance sampling more could have been made of sequential sampling, representing as it does the more recent developments of the subject. The treatment of sequential sampling is restricted to four and a half pages, and deals only with the method of construction and use of sequential schemes for fraction defectives.

The sections of the book on "Statistical Methods" are far too brief and sketchy to be of much value to a person relatively new to the subject. Moreover, some inaccurate expressions and formulae appear, such as the one given for the standard error of the value of a variable predicted from a linear regression equation.

Subject to the limitations stated above, the book should prove a satisfactory introduction to the construction and use of quality control charts, but the more serious student, who wishes to acquire an understanding of the underlying statistical principles, would need to refer to other statistical text-books dealing in greater detail with this important part of the subject. O. L. DAVIES.

7.—*Tables of the Binomial Probability Distribution*. National Bureau of Standards; Applied Mathematics Series 6. Washington: Government Printing Office, 1950. x + 387 pp. 10 $\frac{1}{2}$ " x 7 $\frac{1}{2}$ ". \$2.50.

Some years ago a table was published of the individual terms, and of the sums of those terms, of the Poisson limit to the binomial probability distribution (*Poisson's Exponential Binomial Limit*, by E. C. Molina, 1947. New York: D. van Nostrand Coy. Inc.). This table saves much tedious computation where problems arise in which individual Poisson terms, or the partial sums of the series, are required. Both such needs had been catered for for a long time by Tables LI and LII of *Tables for Statisticians and Biometricians*, Part I (Cambridge University Press), originally computed in 1914, but Molina's tables represented a considerable extension of the range to which the computations were carried. A similar service has now been performed for those who want the individual terms, and the sums of those terms, of the binomial probability distribution itself. The distribution is too well known for it to be necessary to comment on the uses to which this table can be put; suffice it to say that in addition to problems of fitting the distribution to observed data many problems arise, particularly in sampling, where the sum of quite a considerable number of terms of the series is required. The exact answer is now available over a considerable range of the parameters, so that one need not be tempted to use the normal curve approximation in cases where it may lack accuracy.

Table I gives, to 7 decimal places, the values of

$$\binom{n}{r} p^r q^{n-r}$$

for $p = 0.01$ (0.01) 0.50, $q = 1 - p$; $n = 2$ (1) 49; $r = 0$ (1) $n - 1$. Successive terms, in descending order, for a given n occupy adjacent columns of 50 lines each, corresponding to the 50 values of p for which the function is tabulated. Thus the arrangement of the table is a neat one, with p running from 0.01 to 0.50 down both the left-hand and right-hand edges of the page, each page having 6 columns. The numbers are not, therefore, too crowded, but from the point of view of modern table-making standards, designed for clarity and ease of extraction and to avoid eye-strain, the table suffers from the defects that each entry is a continuous string of 7 figures, and the columns are not broken up into blocks. This is, however, the fault of the original mimeographed table, since the book is a photographic reproduction. In places it would have been a relief to the eye, and would have economized space (although at the cost of the standard page), if strings of 7 zeros could have been omitted. It was not, of course, necessary to tabulate for more than 50 values of p , owing to the symmetry of the relation between p and q .

Table 2 gives, to 7 decimal places, the values of the partial sums

$$\sum_{s=r}^n \binom{n}{s} p^s q^{n-s}$$

1951]

for $p = 0.01$ (0.01) 0.50, $q = 1 - p$; $n = 2$ (1) 49; $r = 1$ (1) n . The lay-out is exactly as in Table 1, but entries ending in 5, or in zeros succeeding a 5, are followed by a minus sign (—) or a comma (,) to signify that the true value is less than or exceeds the tabular value respectively. This will assist accuracy when the table is used to fewer figures than seven; the innovation of using a comma may be suspected as being due to the lack of a plus-sign on the typewriter used for the copy. In this table also there are a good many strings of 7 zeros, and also of unity followed by 7 zeros, but the intention was evidently to fill up the entire page.

The statistician will admire, and be grateful for, the industry which has led to the production of this volume, which will have an acknowledged place on every computer's shelf. An introduction deals, among other topics, with recommended methods of interpolation. J. WISHART.

8.—*Acceptance Sampling: A Symposium*. Washington: American Statistical Association, 1950. iv + 155 pp. 9½". \$1.50.

This book is the report of a one-day symposium which constituted the 105th annual meeting of the American Statistical Association at Cleveland, Ohio, held on January 27th, 1946. It consists of the papers presented to the symposium, the prepared discussion which followed, and a verbatim report of the further unprepared discussion with which the two sessions concluded. The book falls into two halves, corresponding to the morning and afternoon sessions which were devoted to the two methods of acceptance sampling—by attributes and by variables respectively.

Of the papers presented on acceptance sampling by attributes the first is by Paul Peach, and deals with the development before the entry of the United States into the war in 1941; the second is by E. G. Olds, and describes the war-time development in this field on the other side of the Atlantic. Any reader familiar with the corresponding developments during the war in this country can hardly fail to draw comparisons between the courses of events in the two countries. He will be struck immediately not only by the similarity of the general lines along which development proceeded in each country, but also by the similarity of the less important ideas and arguments which is revealed in the general discussion. There were, however, a number of differences in the British and American approach, and these are underlined in the book by the occasional reference to British schemes during the course of the papers and discussion.

The second part of the book, dealing with acceptance sampling by variables, consists of two papers, one by John H. Curtiss on "Lot Quality Measured by Average or Variability", and one by W. Allen Wallis dealing with "Lot Quality Measured by Proportion Defective". These and the subsequent discussion are rather more theoretical than the earlier papers, and the industrial user of statistical techniques in this country should find both very stimulating. Very little was said of sequential methods during the symposium, but while this is to be regretted, it would hardly be fair to expect the whole field of statistical techniques to be covered in a single symposium.

The book contains excellent bibliographies, and it should prove very useful to the serious student of statistical applications to industrial problems. He should bear in mind, however, that despite the many eminent statisticians who contributed to the symposium, the book represents American rather than British experience. The delay of some four years in publishing is unfortunate, but any future historian of the development of acceptance sampling has an invaluable source in this book. It can only be regretted that no such written record exists of the corresponding development in this country. DENNIS NEWMAN.

9.—*Demography*. By P. R. Cox. Cambridge University Press (for the Institute of Actuaries and the Faculty of Actuaries), 1950. xii + 326 pp. 9". 20s.

This is one of a series of books published for the Institute of Actuaries and the Faculty of Actuaries and intended principally for actuarial students. There are two important aspects of the book which are presumably the result of its *raison d'être*. In the first place the author's attention is particularly concentrated on England and Wales; Scotland is allotted a brief chapter near the end of the book, and the rest of the world is barely mentioned. Secondly, a knowledge of the use and construction of life tables is assumed; these topics are dealt with at length in two other books in the same series: *Life and Other Contingencies* by Hooker and Longley-Cook, and *Mortality and Other Investigations* by Bone and Haycocks. These points are not mentioned in criticism of the scope of the book: in a study of so vast a subject a well-defined range of inquiry is a definite advantage.

In his introductory chapter the author defines demography as "the study of human populations by statistical methods", and claims for his subject the status of a science, many of the aspects of which "can be pursued by intellectual research without any specific objects, such as the determination of the policy of a political organization". As in many other fields of study concerning human beings, the experimental method is not available. The demographer has to be content

to interpret as best he can the population changes which are continually taking place. But these changes must first be measured, and Chapters 2-5 of this book are concerned with the sources of data from which the structure and changes of the population of England and Wales are assessed. These chapters are admirably done; they deal respectively with the census, registration of births, deaths and marriages, data on miscellaneous subjects such as migration and disability, and (very briefly) with certain sampling investigations. The definition of a stratified sample given in §5.3 is perhaps too restrictive, as it does not allow for the sample to contain unequal proportions of individuals from the different strata.

Chapters 6 and 7 concern the analysis of mortality data. There are many ways of approaching standardization procedures. The author wisely regards standardization as a device for *comparing* in a single index the mortality experience of two or more populations with different age structures, rather than one for producing standardized rates having any importance in themselves. He follows Yule in showing that the indices most frequently used for comparing two populations may be regarded as weighted means of the ratios of corresponding age specific death rates. The various methods differ merely in the weights: in the method of direct standardization the weights are the actual numbers of deaths in each age-group of the standard population; in the indirect method the weights are the expected deaths in the particular population at standard rates, and for the Comparative Mortality Index the weights are intermediate between those used in the other two methods. Chapters 8, 9 and 10 deal respectively with the measurement of fertility, the analysis and significance of marriage data, and the measurement of disability. In §8.14 it is stated that "the relative numbers of the sexes at birth do not vary significantly according to mother's age"; but since the publication of the *Registrar-General's Annual Review for 1938*, which is the authority referred to here, it has been shown by several authors that the ratio of male to female live births declines with increasing maternal age (cf. Lowe and McKeown, *Brit. J. Soc. Med.*, 4, 75 (1950)).

Chapter 11 contains an excellent summary of the growth of population in England and Wales, particularly since the mid-19th century, when reliable data first became available. This leads naturally to Chapters 12 and 13, in which methods of estimating future populations by projection are discussed. The general principle now in favour is to extrapolate mortality, fertility and migration rates for different sections of the population. The actual technique of projection depends on how finely the population is subdivided; a simple method might be based on 5-year age and sex groups, while a more refined method might introduce the effect of duration of marriage on fertility. But differences in technique are fairly unimportant compared with the effect of different assumptions about the future levels of mortality and fertility. Projections of the population of England and Wales, or that of Great Britain, made by five different authors between 1935 and 1944, are discussed in Chapter 13; in spite of the intervening war the 1951 population was under-estimated in each of the nine projections made by these authors. It is clear that we should examine collectively projections based on various plausible hypotheses about future mortality and fertility, rather than pin our faith on some single projection. Mr. Cox makes a plea that alternative hypotheses used in projection should be chosen so that the effects of different levels of mortality and fertility can be assessed *separately*.

Demographic data for Scotland are very briefly discussed in Chapter 14. Chapter 15 brings together various otherwise unrelated topics, including population mathematics. The mathematical treatment here follows A. J. Lotka, and concerns the growth of a "stable" population (one with a fixed age and sex distribution, with constant mortality and fertility rates at each age, and no migration). The net reproduction rate plays a fundamental part in this analysis, but owing to the artificiality of the assumption of constant mortality and fertility rates, this fact is of mainly academic interest. The book ends with an addendum containing a useful summary of the Report of the Royal Commission on Population.

Mr. Cox has written a book whose value will be widely appreciated by students, teachers and other workers outside, as well as within, the actuarial world. His exposition is objective and lucid. The arrangement of the text in short numbered sections (about a page long on the average) makes for easy reference; it would, however, have been useful if dates had been attached to the papers listed in the bibliography at the end of each chapter.

P. ARMITAGE.

10.—*Population Census Methods* (Population Studies, No. 4). ST/SOA/Series A. United Nations, Lake Success, 1949 (London, H.M.S.O.). xii + 197 pp. 11". 15s.

This report has been prepared to help Member States of the United Nations to improve the comparability and quality of data collected in population censuses taken in 1950 or approximate years. It is arranged in chapters, each dealing with a particular characteristic recommended for inclusion. In each the recommendations of international agencies are discussed, chiefly those of the

1951]

Population and Statistical Commissions of the United Nations and of the Committee on the 1950 Census of the Americas; then follows a survey of the methods and definitions used in recent censuses, and of the tabulated statistics presented in the census publications. No less than 53 censuses were examined—those of every independent country where a population census had been taken since 1925, omitting Non-Self-Governing Territories, countries no longer independent, and those for whom information was not available.

The Population Commission recommended the following topics for inclusion in 1950 censuses: (i) total population; (ii) sex; (iii) age; (iv) marital status; (v) place of birth; (vi) citizenship (legal nationality); (vii) mother tongue; (viii) educational characteristics; (ix) fertility data; (x) economic characteristics—(a) total economically active and inactive population, (b) occupation, industry and industrial status, (c) population dependent on various types of economic activities, (d) agricultural population; (xi) urban and rural population; (xii) households (including relationship to household head). Of these the Population and Statistical Commissions were agreed that the most important were total population, sex, age, marital status and economic characteristics.

In the discussion on the relative merits of *de facto* and *de jure* enumeration of total population it is suggested that whereas the former is generally simpler and easier for international comparisons, the latter is more useful for internal and national purposes such as electoral representation. The recommendation of the Population Committee and the Committee on the 1950 Census of the Americas was for a modified *de facto* total population, i.e., the total enumerated population minus foreign military and diplomatic personnel in the country plus military and diplomatic personnel stationed abroad. As a rule earlier censuses surveyed differed in their treatment of these special groups, e.g., in the 1931 Census of England and Wales there was no provision for persons temporarily out of the country, but 31 out of the 53 censuses examined gave both *de facto* and *de jure* totals. Special attention is drawn to the difficulties encountered in enumerating nomads, aborigines, fishermen and seamen, and a warning is given that there is need for a check of under- or over-enumeration.

Questions on sex and age were common to all the 53 censuses, but the tabulations prepared did not show the same groupings. The Population Commission recommended that the tabulations should show for each sex the numbers by completed years of age in the following grouping: under 1 year of age, by single years from 1 to 4, and thereafter by 5-year groups to the end of life. Persons for whom the ages were not stated were to be shown as a separate group, or if the ages were estimated and this group allocated among the known ages, the methods used were to be stated. One of the most serious criticisms of the censuses studied was that such allocations, whether for age or other characteristics, were apparently made in completing tabulations, but no information was provided on how this was done. Such omissions can interfere seriously with international comparability of census statistics. On the question of age the discussion ranges over the difficulty of accuracy of enumeration, and the relative merits of recording the date of birth or the age at last birthday.

There was great diversity of practice in the different censuses studied in the treatment of marital status. Most showed the numbers married, widowed and single, but there was a lack of exact definitions, particularly concerning *de facto* unions and those separated. The Population Commission recommended division into the following four categories: (a) married, including persons in stable *de facto* unions, (b) widowed, not remarried, (c) divorced, not remarried, and (d) single, i.e., not (a), (b) or (c). In addition (a) could be subdivided into those persons formally married and those in *de facto* unions.

Enumeration of the economically active population has usually been made using the "gainful worker" concept, based on a person's assumed stable function and independent of his activity at any given time. The recent recommendations of international agencies favour the "labour force" concept, which refers to a person's activity during a specific period. This concept is considered to be more precise and objective, but it may be unsuitable where there are gross seasonal and other temporary changes in economic activity, such as in some agricultural occupations. This volume does not give a detailed discussion or recommendations on the classification by industry and occupation, but refers to reports of the Statistical Commission and International Labour Office. On the question of occupational status a classification into (i) employees, (ii) employers, (iii) persons working on their own account and (iv) unpaid family workers is recommended. This classification is independent of those by industry and by occupation except where subdivisions of group (i) are attempted, e.g., into managers and directors, professional workers, domestic workers, etc. Group (iv) often provides difficulties in definition.

One of the chief difficulties in enumerating the population dependent on agriculture is that it is not the same as persons deriving their livelihood from agriculture. The Population Commission recommended that with this, and other occupations, all those economically active should be assigned to their respective occupations, the economically inactive being recorded as dependants of the head of the household. The agricultural population could also be defined according to occupation, farm

residence, or where the chief source of income was from agriculture. Of these the first is preferable in population censuses. A special chapter is devoted to the value and technique of collating the results of population and agricultural censuses.

The other topics recommended by the Population Commission for inclusion in 1950 censuses are discussed in separate chapters, a particularly interesting one being concerned with fertility data. The use of sampling in censuses, which would be essential if all the topics were to be included at a reasonable cost, is not discussed except briefly in relation to agricultural censuses, but reference is made to the Reports of the United Nations Sub-Commission on Statistical Sampling. Altogether the study is excellently presented and clearly written, and will be invaluable to all those who are concerned with the preparation of population censuses or the interpretation of the tabulated data.

J. KNOWELDEN.

11.—*Annual Bulletin of Transport Statistics. First Year : 1949.* Economic Commission for Europe, Transport Division, Geneva, 1950. (1950, II E.2.) 57 pp. 11¼". \$0.50. Bi-lingual : English and French.

This bulletin consists of ten main tables, giving for the years 1938, 1948 and 1949 statistics of (1) railway traffic, (2) permanent way, (3) mobile equipment (locomotives), (4) mobile equipment (passenger carriages), (5) mobile equipment (freight rolling stock), (6) length of road network, (7) number of road vehicles, (8) volume of inland waterway traffic, (9) length of navigable waterways, and (10) craft in service. These are preceded by a useful survey of the data of 13 pages on "The Transport Situation in Europe", in which the figures are analysed and commented upon with the aid of many supplementary tables and graphs.

It cannot be said, however, that the bulletin lives up to its title. In the first place "Europe" is limited to 14 countries only; no data are given for any of the so-called "Iron Curtain" countries, nor for Greece, Ireland (North and South), Portugal, Spain and Yugoslavia. The tables are based, for 1949 and in some cases for 1948, on replies to a questionnaire, but the list of countries to which it was sent is not given. The omission of some of these countries is the more surprising, as many of the data have already been published in other sources, e.g., the *United Nations Statistical Year Book*, 1949-50, and comparison of the figures given therein with those given in the Bulletin for these 14 countries reveals numerous differences which it is not possible to explain from the information available. Secondly, the scope of the Bulletin is somewhat limited. In Mr. Menzler's article on "Rail and Road Statistics" in Part III, 1950, of this *Journal*, he gives (p. 353) nine categories of data which transport statistics should in his view be "presumably expected to cover". This Bulletin contains no information on five of these, viz., fixed assets, staff, expenditure, revenue and economic efficiency, and very little on operating efficiency. "Derivative statistics" necessary for measuring the latter are limited to "average load per wagon" and "average haul per ton" for railways. Thirdly, transport by air is excluded. No reason is given for its exclusion.

This first Bulletin, though good as far as it goes, is capable of much improvement and expansion before it can be said to give an adequate picture of what it calls "the transport situation in Europe".

J. W. NIXON.

12.—*The Dynamics of Business Cycles; a Study in Economic Fluctuations.* By Jan Tinbergen and J. J. Polak. London: Routledge, 1950. x + 366 pp. 8¼". 25s.

This book is a translation of a work in Dutch which was first published in 1942. Dr. Polak has deleted some material, and rewritten certain sections (particularly the chapter on war inflation), but the book has not been "brought up to date" as the publishers claim. It remains a book based on pre-war material, a very good book for its time, but one in which subsequent developments would require substantial alteration.

The scope of the work is wider than its title. Professor Tinbergen deals with long-run trends, interruptions and changes in structure, seasonal and random movements, as well as the long waves, business cycles, and special cycles of the usual treatment of the subject. The discussion is divided into three sections: description, which begins with a useful discussion of types of movements; explanation, which contains an interesting analysis of long-run development; and business-cycle policy, which contains a good if somewhat prolonged discussion of the likely effectiveness of various kinds of policy, and comes down strongly in favour of the stabilization of demand (rather than of income) by compensatory fiscal policy. Throughout, the exposition is elementary and severely non-mathematical—perhaps too much so for the probable readership.

Professor Tinbergen's approach is highly econometric: while the theoretical background is competently expounded, it is quickly translated into significant observable and quantifiable relationships, leads and lags. The emphasis on significance and quantifiability is an important

1951]

advance towards useful theory; but the transitions are rather sudden, and often seem to be dictated by the statistics rather than suggested by the economics. The question of significance also raises the difficult problems of statistical inference from time series, a matter on which a great deal has been done since the war but which Professor Tinbergen does not discuss. The link between theory and statistics is a central problem for econometrics, and its treatment here seems rather to assume away the difficulties.

The heart of the book is the theory of endogenous cycles expounded in Chapter XIII. Professor Tinbergen rejects the acceleration principle, and bases his cyclical process on changes in capital values which, he asserts without much discussion, are treated as income changes by their recipients. His model, which is expounded by means of Example III (p. 199), may be expressed mathematically in the form

$$y_t = ky_{t-1} + (y_{t-1} - y_{t-2}),$$

where the y 's are deviations of (quarterly) income from normal and k is the marginal propensity to spend. The odd-looking term $(y_{t-1} - y_{t-2})$ suggests double-counting, but is designed to introduce "speculative income" changes on the assumptions that share prices vary with current profits, and current profits vary with income. The three links in the chain income-profits-share prices-income seem rather weak, and this is particularly important, because a linear model of this type requires special values of the coefficients to make it oscillate. More recent business-cycle theory would employ the less restricted formulation of a non-linear model; it would also favour a sophisticated accelerator as opposed to capital gains as the source of oscillation, attempt to link the cycle more closely to the trend, and perhaps be more careful about assuming a stable marginal propensity to spend.

Criticism of a pioneering work in a rapidly developing subject is inevitably unfair. It is extremely useful to have this book available in English, both as a statement of Professor Tinbergen's theoretical framework and his more important results, and as an outstanding specimen of that rare and desirable bird, econometrically-orientated theory.

HARRY G. JOHNSON.

13.—*Inventories and Business Cycles, with Special Reference to Manufacturers' Inventories.* By Professor Moses Abramowitz. National Bureau of Economic Research Inc. New York: 1950. xxxv + 632 pp. 9" \$6.00.

However much one might disagree with Professor Abramowitz's methods, and even his conclusions, there is little doubt that he has done a very useful piece of historical research in a field hitherto somewhat neglected. The author sets out to discover what happened to (a) the level of stocks and (b) investment in stocks (in the National Income sense of the word) in the inter-war period, and to compare his findings with the views, largely based on deductive reasoning rather than on facts, put forward by various trade cycle theorists. Particular attention is paid (in the introductory chapter) to Metzler's trade cycle work, which leans heavily on inventory cycles as an explanation of movements in general activity.

The study of fluctuations in stocks of goods during the inter-war period is not by any means a new pursuit; Professor Abramowitz has, however, four good reasons for writing 600 pages on this subject. Firstly he rightly points out that investment and disinvestment in inventories accounted for a substantial part of the movements in GNP during the trade cycle, a fact which is probably not as well known as it ought to be; he shows that the average change in inventory investment was about 23 per cent. of the average increase in GNP during the five inter-war expansions, whilst changes in inventory investment during contractions accounted for as much as 40 per cent. of the average decline in GNP. Secondly, a good deal more statistical information on stocks has become available in the last 10 years. Thirdly, previous writers thought mainly in terms of aggregate stocks, which the author shows is a grossly over-simplified approach to the problem. Fourthly, in the past, trade cycle economists, whilst arguing about "investment" in stocks, generally offered evidence about the "level" of stocks, which is not very convincing—indeed investment in stocks may well start to go up or down before the trough or peak in the level of stocks is reached. In other words, evidence about movements in the level of stocks is not necessarily enlightening as far as fluctuations in inventory investments are concerned. Implicitly rather than explicitly the author makes a further point in favour of detailed factual research; he shows that trade cycle economists by and large violently disagree about the amplitude, timing, explanations, etc., of stocks, and seems to argue that the final answer can only be given by a study of the facts. In his concluding chapters he has, however, to admit that owing to paucity of data his findings are far from conclusive.

It is difficult to summarize Professor Abramowitz's conclusions, partly because they are so numerous, partly because they are fragmentary and rather vague; it is not easy to decide what is

a fairly firm result, and what a mere indication of a possible theory. Broadly speaking he attempts to establish the timing and amplitude of cycles in (a) the level of stocks and (b) investment in stocks, *vis-à-vis* fluctuations in general business. His conclusions are largely tentative, for which he can hardly be blamed; questions of short lags and leads between inventory cycles and business cycles simply cannot be answered from annual data, and deficient annual data at that. In view of the fact that his book is essentially concerned with movements in physical stocks, Professor Abramowitz might be criticized for spending a good deal of time discussing fluctuations in the *value* of stocks, a pursuit for which he himself finds it difficult to put up a good defence. As regards the *volume* of stocks, "the solid characteristic of inventory behavior that could be established with the presently available data" is that it tends to lag behind the business cycle by 6-12 months, probably nearer 6 than 12. Bearing in mind that over the last hundred years expansions lasted on the average 26 months and contractions 21 months (National Bureau estimates), a 6-12-months' lag means that (manufacturers') stocks declined for about one-third of the average expansion and continued to increase for over one-third of the average contraction. Whether in the circumstances one chooses to say—like Professor Abramowitz—that movements in stocks "tend to conform to business cycles with a long lag" or—like Blodgett—that they do not conform at all, is partly a matter of choice, and partly a question of the views one holds on the average length of the trade cycle; obviously during the shorter expansions and/or contractions a 6-12-months' lag implies that stocks move counter to the business tide for over half a phase. Fluctuations in the main subdivisions of total stocks, i.e., in raw materials, goods in process, and finished goods, are discussed in great detail and the necessity for such a detailed analysis conclusively proved. The section on goods in process about which there is little statistical information available is particularly ingenious and of considerable theoretical interest.

It is disappointing that the author does not devote more time to comparing his own conclusions with those of previous writers. Keynes is one of the few authors whose inventory cycle theories are discussed at some length. Very briefly it may be said that Professor Abramowitz's findings do not corroborate Keynes' theory about liquid stocks as far as cycles of short or moderate length are concerned; Keynes' hypothesis does, however, correspond to the "recorded behavior of finished staples held by manufacturers" during long (i.e., more than 6 years) cycles. Again, Professor Abramowitz's conclusions are hedged in a number of ways, e.g., the only stocks which correspond to Keynes' definition of liquid stocks and for which adequate data are available are manufacturers' inventories of finished staples; it follows that other stocks may well meet Keynes' specifications even for the shorter cycles.

As far as fluctuations in inventory "investment" are concerned Professor Abramowitz reaches the extremely interesting conclusion that investment in stocks lags behind the rate of change in output, and that this both moderates the pace and extends the duration of expansions and contractions. According to the author, "the rate of increase in output is usually at a maximum long before the peak in business, often before half the expansion has run its course. Similarly the rate of decline in output is usually at a maximum long before the trough in business". There is no evidence, however, of a lag or lead between inventory investment and the movements in *general business*.

One further important conclusion reached by Professor Abramowitz should be mentioned. His analysis shows that "changes in inventory investment are significant in short expansions and contractions. But the longer the phase, the smaller the contribution of inventory investment to the further advance or decline of business. Obviously, the longer the phase, the more it must depend upon consumers' expenditures or business investment in plant and durable equipment for its motive force. In this significant but limited sense it seems appropriate to think of short cycles as inventory cycles while longer movements are identified with other categories of demand." These conclusions support to some extent the views of Hansen who (following the lead of Schumpeter) distinguishes between the 50-year "long waves", 8-year "major" cycles and 3- or 4-year "minor" cycles, and finds that minor cycles are caused "not infrequently" by fluctuations in inventory investment. Professor Abramowitz's own opinion is that in the absence of monthly data it is not possible to decide "whether the shorter declines of business are initiated by the appearance of saturation in the demand for additional inventories or by failure of demand for other kinds of goods". The four chapters which follow this statement are given to providing an explanation of the behaviour of inventory investment. Unfortunately the explanations are almost entirely of a qualitative nature as, owing to the paucity of statistical data, the author does not find it possible to back his arguments by facts.

Two main criticisms may be directed at Professor Abramowitz's book. The first and the lesser of the two refers to the presentation of his material. In drafting a report of this kind one of the most difficult things is to decide what to leave out or at least relegate to technical appendices. Whilst the author is to be congratulated on the wealth of detail he gives, a great deal of methodo-

1951]

logical and explanatory matter is out of place in the main text of the book, with the result that one cannot see the wood for the trees. Professor Abramowitz would have earned the gratitude of his readers had he presented a much shorter and consequently more readable account of his findings. As it is—and the author himself is aware of it—the book makes very tedious reading, and for this very reason may not be read as widely as it deserves.

The second and more serious criticism derives from the simple fact that the book was written by an economist, whereas it ought to have been the work of an econometrician. One is more than a little surprised to see that in the year of grace 1950 a problem of this kind is treated strictly and wholly by non-mathematical methods. The reviewer sees no reason why inventory cycles should not have been studied along the now familiar "multiple regression-confluence analysis" lines Tinbergen followed in his well-known work on business cycles. Certainly this kind of approach should at least have been tried. But quite apart from the question of econometric *versus* historical treatment there are serious indications of statistical carelessness—in an inquiry which is essentially of a statistical nature. A few examples are given below. Whilst not of overwhelming importance taken individually, these slips add up to fairly weighty adverse evidence.

In Table 40, estimates, obtained from two different samples, are given for the percentage which "goods in progress" represent of total inventories; the estimates are 19.1 per cent. and 15.7 per cent. Professor Abramowitz is of the opinion that the difference may well be due to sampling errors, but no attempt is made to determine the sampling variance. Bearing in mind that the samples in question were both drawn from finite universes and that the sampling fractions are fairly large, it is not by any means clear, or even likely, that a difference of this magnitude between the percentages would be due to sampling errors; there is, therefore, every reason why the sampling variance of the difference between the two "P's" should have been calculated. Again, at an early stage of the report and repeatedly afterwards the author discusses at considerable length the *average* lag between inventory cycles and movements in general activity, but fails to give any measure of variation in the lags series (although on p. 60 he states that average deviations will be computed). Someone once jestingly described the theory of statistics as the science of σ . Whilst this may be a gross over-simplification, discussions of "averages" unaccompanied by measures of variation are not particularly enlightening.

Finally some "index number theory" examples: (i) In connection with one of his price indices Professor Abramowitz says (page 92): "a second element of crudity inheres in the fact that the commodity price series in our indices are far outnumbered by the commodities included in inventories". But to include in the index price series for all the commodities that find their way into inventories would be quite unnecessary and wasteful perfectionism. The generally accepted method of computing price index numbers is to use a "representative" sample of prices; except in very special circumstances no one would think of including price series for every commodity under consideration. All that is required, of course, is that the price series used should be broadly representative of the movements of the prices which are not included. (ii) On p. 91 the author mentions in connection with his price index for goods in process and finished goods that he was unable to estimate changes in overhead costs. This is another instance of perfectionism. It is quite clear that in this particular case it would have been better to make, however rough, an estimate of changes in overhead costs—almost certainly it would have been possible to guess at least the direction of the change—rather than assume no change at all, which apparently was the procedure adopted. Whilst throughout the book there are indications of a regrettable perfectionist tendency, there is no attempt to quantify errors. Admittedly the data are unsuitable for treatment by probability methods; there are, however, simpler means of making rough estimates of the possible error involved, e.g., by making alternative (likely) assumptions and comparing the two estimates thus obtained. In one or two cases this is done, and confidence in the conclusions greatly strengthened.

These few examples do not probably succeed in conveying the general impression one gets that the statistical treatment of the various problems encountered is inadequate. Whether and to what extent Professor Abramowitz's final conclusions are invalidated by the statistical shortcomings of his methods is beyond the scope of this review. But there is no doubt that *Inventories and Business Cycles* is well worth reading, not only for its wealth of documentation, but also for the stimulating ideas with which the economic argument is well laced.

A. P. ZENTLER.

14.—*Taxes, the Public Debt and Transfers of Income*. By Donald C. Miller. (Illinois Studies in the Social Sciences, Volume XXXII, No. 1.) Urbana: The University of Illinois Press, 1950. xi + 153 pp. 10". \$2.

The subject of this book is an economic-statistical investigation of the effect of the greatly increased public debt in the United States, and of the resulting transfer problem upon the distribution of income and upon the level of the national income. The investigation was carried out

for the year 1945. It involved two separate sets of calculations: (i) the allocation of federal taxes among the various income groups (summarized in Table 23); (ii) the allocation of the interest on the federal debt among the various income groups (summarized in Table 40). Six income groups were distinguished, of which five were below \$5,000, and the sixth \$5,000 and over. The \$5,000 income level was also regarded as the dividing line between the high and low income groups.

In the allocation of taxes the author follows, with minor alterations, the precedents of such studies in the field as those of Shirras and Rostas and Barna in this country and Colm-Tarasov in the United States, although he painstakingly reviews once more all the relevant theoretical views on shifting and incidence. Students will find this survey a convenient summary. His procedure is briefly as follows: He allocates the individual income tax on the assumption that no shifting occurs. Corporate taxes are allocated on two alternative assumptions: (a) that they are borne by the stockholders of the corporation in proportion to the amount of dividends received in the particular year under consideration, and (b) that two-thirds are borne by the stockholder while one-third is shifted on to the consumer and allocated on the basis of total consumer expenditure. Social security taxes on employees are assumed to be not shifted, while employer taxes are assumed to be borne by the employer, employees and the general consumer respectively. The first part is allocated to income groups on the basis of receipt of dividends. Estate and gift taxes are treated in a somewhat cavalier fashion, and allocated entirely to the income groups above \$5,000.

The allocation of the indirect taxes involves the determination of expenditure pattern—an easier task in the United States in view of the wealth of information available on family budgets. Certain excises are distributed on the basis of aggregate expenditure on these particular products. This is applied to tobacco and liqueur duties; the latter are allocated 25 per cent. to the lower income groups and 75 per cent. to the higher income groups. The rest of the excises are distributed on the basis of food expenditure, clothing expenditure or total consumer expenditure, e.g., federal excise taxes paid by motorists are partly allocated on the basis of personal expenditure on motor cars and partly on that of total consumer expenditure. Altogether 24 per cent. of federal excise taxes are attributed to income groups above \$5,000. Import duties are treated in the same way as excises, and assumed to fall upon consumers of the products concerned.

The author's more original contribution is in the allocation of the interest on the federal debt to income groups. First, interest is attributed to investor groups receiving such payments, such as commercial banks, mutual savings banks, insurance companies, corporations and individuals; secondly, interest is allocated within each investor group to the several income groups. This latter process is a very complicated one, and cannot be described here in detail. One's impression is that the allocation is probably more reliable between the two main groups, i.e., the over \$5,000 and the below \$5,000 than between the five lower groups.

In order to illustrate the distribution of income through public debt, with a given tax structure for 1945, the author assumes that each taxpayer pays part of the interest on the debt. As the federal debt in 1945 accounted for 7 per cent. of the total federal tax receipts, he assumes that 7 per cent. of all federal taxes were used for the payment of the interest. Similarly 7 per cent. of each taxpayer's liability is used for the payment of interest on debt. It appears that 59 per cent. of the interest goes to the upper classes, and that they pay 56 per cent. or 50 per cent. respectively (on his two assumptions in respect of the treatment of corporate taxes). In either case the redistribution is extremely small, of the order of \$87 million or \$234 million against a total debt burden of \$2,820 million. That means that in 1945 the progressivity of these two systems was fairly similar.

An additional short calculation is made by the author on the effect of the redistribution on the income flow, due to different marginal propensities to consume in the income groups concerned. His conclusion again is that the effect of the redistribution on the income flow was extremely small: he puts the total reduction in income at \$225 million. This should be related to the national income, to the size of debt or to the total interest payments. He concludes, therefore, that in 1945 the public debt had neither important redistributive nor important deflationary effects.

One interesting by-product of his study is a comparison of the distribution of United States Federal taxes among income groups in 1945 and in 1938 (see Table 24); the latter is based on the Colm-Tarasov study. The striking result of this comparison is the shift in the concentration of the federal tax burden from the lower income groups in 1938-1939 to the higher income groups in 1945.

Altogether this is a well-documented and scholarly book. The author explains step by step the methods which he follows, and introduces us to the intricacies of the statistical material which he uses. British research workers will envy him for the vast amount of supporting statistical material (on such subjects as family budgets, consumer finance, etc.) which is available in the United States and makes such studies possible.

L. ROSTAS.

1951]

15.—*Economics for Commercial Students and Business Men*. By Albert Crew, enlarged and rewritten by Leo T. Little. 13th ed. London: Jordan & Son, 1950. viii + 591 pp. 7½". 12s. 6d.

Some knowledge of economics is nowadays required as part of many professional qualifications, and budding business men who seek to find their way to the Managing Director's chair via the evening class room are enjoined to secure a modicum of the science. It is for such readers, the potential company secretaries, accountants, municipal treasurers and rating and valuation officers, as well as the miscellany of students who take the examinations of the Royal Society of Arts and the London Chamber of Commerce, that Mr. Little's text-book is designed.

Such students, if they master the contents of this book, will, indeed, be better equipped for their respective callings. But will they master it? The reviewer can but wonder what the future municipal treasurer, as he does his private study between office and night school, will make of Mr. Little's Chapter 21, "Keynesian Economics". The fault lies, not with the author, but with the examiners, a selection of whose questions appear at the end of each chapter. These gentlemen expect a very great deal. For instance, the accountant who seeks to become Incorporated should be able to "estimate the significance of the purchasing power parity theory in determining equilibrium rates of exchange at the present time." The candidate who is confronted with this question might well wish that he had been taking the Royal Society of Arts, Intermediate, in 1947, for then he might have succeeded in hiding any ignorance of the theory of purchasing power parity, while obeying the examiner's injunction to say why the study of economics is important and "give a brief outline of its terms and principles".

It was, perhaps, a question such as this which inspired Mr. Little to join the ranks of text-book writers. He has achieved a considerable measure of success in his difficult task. The main body of modern economic doctrine is outlined and there is a useful blending of theory and practice. (Chapter 37, "Public Ownership of Industry", for example, is a very neat statement of the pros and cons of nationalization within the compass of seven pages; while Chapter 28, "Various Financial Institutions", has a valuable section on insurance, a subject on which Mr. Little is an acknowledged expert.) These excursions into the real world are, however, space-consuming, and have necessitated a certain amount of condensation of the more theoretical sections. These may puzzle the newcomer to economics. His path is not made any easier by the dearth of references to supplementary sources and the absence of a bibliography. Perhaps in the next edition this deficiency will be made good; such useful trifles of information as the Command number of the White Paper on Employment Policy and the official name of the Macmillan Report will appear in footnotes; and the student may be told in what publications he may find the current values of the various index numbers referred to in Chapter 27. Such small refinements would do much to turn a good book into a better book.

P. A. DANIELL.

16.—*The Conditions of Economic Progress*. By Colin Clark. 2nd ed. London: Macmillan, 1951. xv + 584 pp. 8½". 50s.

When the first edition of this work appeared in 1940, economists and economic statisticians were inspired and perhaps a little dazzled by the courage and brilliance with which the puny resources of quantitative economics were marshalled and used in a direct attack on the fundamental problems of economic analysis. It was regarded, with some justice, as a landmark in the field of applied economics, and the harvest of new ideas and hypotheses which emerged from Mr. Clark's enthusiastic cultivation of so much virgin soil has encouraged a multitude of research workers to push forward his work.

As Mr. Clark points out in his preface, however, the second edition is launched into a very different world: "... the whole aspect of economic teaching and research in England has now been transformed. The study of real and money national income and the causes determining their movements, not as theoretical concepts but as observed facts, is now fully recognized as the essential subject-matter of economics." In response to this revolution and to the demand for a second edition, the author has not merely revised his original work. He has almost completely rewritten it, and by the addition of much new material has increased it to almost twice the size of the original.

The result is the same book in a different intellectual context, and it is surprising how different is the impression which it produces on the reader, different even from the re-reading of the first edition at the present day. It still ranges over an immense field, and it uses factual data collected from an incredible variety of sources in the same bold way. The sheer weight of factual material has been increased out of all proportion to the volume of new ideas, however, and the daring of the original concept seems often closer to sheer recklessness when applied to resources of so much greater variety of quality.

It is to be expected that the second edition will receive a very different reception from the

first. Mr. Clark's keenest disciples will regret that this is merely an extension rather than a development of the first edition. His new audience, brought up on a diet of applied economics, will be more critical than the audience of 1940, to whom it was an exciting new dish. There is some danger that the criticism will be more enthusiastic than discriminating, for it is easy to be critical in this field. The barren wastes which a very few hardy souls dared to till in 1940 have been parcelled out among a multitude of specialists, and their intensive cultivation has produced more fruitful results over small areas, and has developed more sophisticated techniques, than could ever be achieved with the omniscient approach which is the striking characteristic of this book. Those who are prepared to criticize on points of detail will find that Mr. Clark has let himself become vulnerable over a very wide front, and that a decade of rapid development in applied economics has produced a wide choice of ready-made weapons of attack. Anyone who is familiar with the extensive literature now available on real income comparisons, for example, will find it difficult not to be startled by the readiness with which the author accepts the so-called "ideal" index number, and with which he is prepared to adopt American retail prices in 1929 as his standard of comparison in all circumstances. It is difficult enough to accept a comparison between, say, agricultural productivity in China and India in these terms, but the final "Excursus" in which an attempt is made to apply this standard to the level of real incomes in ancient Greece and Egypt reads almost like a parody of the method.

It would be a pity, however, to lose sight of the wood for the trees. A major source of strength in Mr. Clark's approach to these problems lies in his breadth of view, and in these days of increasing specialization there is a great deal to be said for the broad view. If it prevents him from being as profound as the specialists would wish for their particular topics it has not made his treatment thin, as it well might have done. It is now beyond the realms of possibility that any one scholar would have consulted all the sources which are relevant to this immense task, but the number and variety of the sources that are used in this book gives it an almost monumental quality. It is as fascinating, and occasionally as indigestible, as an encyclopaedia.

It is unfortunate that inadequate indexing and planning, unsatisfactory bibliographical references and avoidable inaccuracies detract from the undoubted value of the book as a work of reference. Many research workers will sigh for a list of tables (some of the tables are not even labelled), and for a bibliography of sources. The chapters run into hundreds of pages, often in note form, and it is frustratingly difficult to find particular references. Nevertheless, the university teacher and student will find this an invaluable text in applied economics which is not the less stimulating or instructive because of its imperfections. We are permitted, as it were, to browse through a research worker's notes and records of his experiments in a vital field. And it must be admitted that although some of us may think we know better ways of tackling some of the experiments than Mr. Clark has applied here, none of the many fundamental methodological problems with which he grapples have in fact been solved. There is still a vast field of discovery for those who follow intelligently in his footsteps.

P. M. DEANE.

17.—*Planning in Practice*. By Ely Devons. Cambridge: University Press, 1950. viii + 231 pp. 8½" 15s.

Four years in the Planning Division of the Ministry of Aircraft Production during the war gave Professor Devons the practical experience reviewed in this book, which is a personal record and in no sense a history of the Ministry. An account is given of the part played by the Ministry in the planning of aircraft production, and its relations with the Air Ministry and the Admiralty in determining the types and numbers of aircraft to be produced. The problems are examined of allocation of steel, timber, and other materials and labour, often involving decisions at Cabinet level because of the competing claims of other departments. Special attention is given to the preparation of the aircraft production programme and to the planning of the supply of engines, propellers, undercarriages, and other components, and there are interesting chapters on labour requirements, the part played by statistics, and the intricacies of the task of co-ordination.

While detailed production arrangements were left to the individual firms, the Ministry dealt with the types of aircraft which should be developed and produced, which firms should develop them, and at what rates. Planning was inevitable to secure the most effective use of materials, factory space and labour, as competitive price-bidding by different users of materials in short supply would not, in wartime, have best met the needs of the fighting services. Money costs hardly ever entered into the discussions, and the Ministry had to finance investment in plant which individual firms would not have undertaken because of the risks involved.

In the preparation of the aircraft programme two main difficulties were encountered, first, the rapid changes in types of aircraft and components, which made the Air Ministry and the Admiralty unable or unwilling to commit themselves to definite statements of their long-term requirements, and second, the unreliability of the deliveries promised by many firms. In the

1951]

planning processes, too, conflicts arose in ensuring both the necessary delegation or devolution and the equally necessary centralization and co-ordination. The co-ordinators regarded the "plans" of the several production sectors as futile because they took no account of what was happening elsewhere, and those in charge of the individual sectors considered the plans of the co-ordinators to be theoretical and unrelated to the real facts. The centralizers had to fight the "planners" in each department, who struggled to have more and more left to their discretion.

The aircraft programme showed, for each firm, the planned monthly delivery rate for each type and mark of aircraft for a period of not less than 12 months or more than 2½ years ahead, and it told the firms which type each was to produce and its rate of delivery. A new type of engine could not come into production for at least 12 months, and the time might be as long as two years. Yet it was hardly possible to get the Air Ministry and the research and development branches of the Ministry of Aircraft Production to commit themselves 18 months or 2 years in advance to a statement of their requirements. Programmes had, therefore, to be amended at frequent intervals, and there were wide margins of error whenever big changes were made in the existing level of output. This was true, for example, when, in the autumn of 1941, the Ministry was asked to calculate the additional resources needed to produce heavy bombers at a rate much greater than that of the current plan. The calculations of labour and raw materials required were largely guesswork.

Another problem was whether firms should be given targets somewhat beyond what each was expected to achieve, or should be given a realistic output figure. The former might be a stimulus, and it also gave a better chance of getting allocations of materials and labour sufficient to produce the lower output actually expected. Though in the main realism prevailed, there was usually a target element in the programme, and in practice, "no aircraft programme was ever achieved 100 per cent. for more than a single month" (p. 38). The programme, narrowed the range of uncertainty, but never eliminated it. The final stages of getting out a programme were always a mad scramble, while "the delay caused by the sheer mechanics of drawing up and issuing a programme always meant that it was already out-of-date at the time of issue" (p. 106).

Many officers of the Ministry were busily engaged in "chasing shortages" of supplies and labour; others gave much time to a form of sport known as "alibi hunting", which involved a running debate as to whether the firm, the production directorate concerned, or some other directorate or Ministry was really responsible when a firm failed to achieve its programme. These debates were nearly always inconclusive, with victory usually going to the official or department cleverest at manipulating figures.

Analysis of past experience, undertaken by the directorate-general of planning and statistics, threw valuable light on the degrees of reliability of estimates of output made by different firms, on the time taken from beginning production of a type or mark to peak production, and on the loss of production through the change-over from one type of aircraft to another. But notwithstanding investigation of all available data, the performance for each type of aircraft and firm compared with each programme told a sorry tale of enormous errors made in assessing productive capacity. A good guide for programme-making was to take a firm's estimate, put it back six months, deduct 10 per cent., and this gave a programme which on the average would probably be achieved about 90 per cent. Attempts to base production on man-hours worked, or on machine tools or floor area per unit of output proved useless because of differences in the efficiency of firms; and scarcity of good management made it impossible to bring the efficiency of all firms up to that of the best, though this was never fully recognized.

The Air Ministry and the development division of the Ministry of Aircraft Production never realized the risks of delaying production of new engines and other components till they were fully proved, which would mean that the Services would have to wait a long time for supplies. Another difficulty with components was that in a period of temporary shortage Air Squadrons would adopt every device to conceal any stocks they had and would make exaggerated demands for new supplies. Depots and Air Squadrons overseas rarely sent reliable reports on their stocks of engines and other spares. "Frantically urgent attempts were made to discover all the nooks and crannies into which supplies had oozed, but usually without much success" (p. 146). In consequence there would be great pressure to increase capacity even though the new capacity would come into production only after the immediate shortage had passed, and would result in surpluses. Rapid technical improvements increased the risk of production of too many out-of-date marks.

The allocation of labour for aircraft production was the main link by which the Ministry's plans were related to those of other departments. Once an overall allocation had been made by the Cabinet or Man-power Committee difficulties had to be overcome arising from differences of grade of skill, and the places where labour was needed. The workers were distributed among more than 10,000 firms, only a few of which had direct contracts with the Ministry, and the extent

and complexity of sub-contracting arrangements were quite astounding. Also, in many firms part of the labour force was not engaged on aircraft production. Consequently, to calculate the amount of labour used in the manufacture of any component proved extremely difficult. So many uncertainties were involved in estimating future requirements that the data available were adjusted by guesses, hunches and prejudices, and finally the statistics division of the Ministry found it expedient to keep its methods of calculation secret. Much time was spent in trying to measure the relative efficiency of firms by comparing output per person employed, but such data were useless for this purpose because some firms did more experimental work than others, some produced several marks of components and others only one, and there were differences in the proportions of skilled workers, dilutees and women employed.

The most revealing chapter is on Statistics and Planning. "Without statistics there can be no planning" (p. 133), which in aircraft production was mainly based on the examination of past production trends and their extrapolation into the future. Production and stock figures were the two most important sets of statistics. The first stage in planning a production programme was the collection of records of actual production in the past, yet except for complete aircraft and engines "untold difficulties" were encountered. It appeared that the firms and the production divisions of the Ministry treated the collection and tabulation of statistics as "inferior, degrading and routine work on which the most inefficient clerical staff could best be employed" (p. 134). In many discussions different sets of data which pointed to conflicting conclusions were often used until, in order to avoid confusion, certain officials were made responsible for compiling the main statistics needed for decisions on policy. Figures were often merely a useful way of summing up judgment and guesswork, and reference is made to a curious process known as statistical bargaining, where two parties each with a different set of figures would agree on compromise data. "Yet it is the failing of the majority of human minds, a failing nowhere more evident than in M.A.P., to assume that anything expressed in figures must necessarily be precise" (p. 155). Once the figures were called statistics they acquired the authority and sanctity of Holy Writ, and the veneration paid to the figures reached its climax if presented in well-devised printed tables.

In extreme cases figures were used by officials who did not know how they had been calculated; the processes by which they had been evolved might be hidden in the mind of some official who had long since left the department, or they might be the result of a statistical bargaining conference, the records of which had never been kept. "No matter how loud the protests of the statisticians that the necessary basis for making a worth-while estimate was not available, officials would insist on some figure being given" (p. 137), and usually any qualifications and limits indicating margins of error which the statisticians gave were soon ignored. Examples quoted show the dangers from the use of statistics and charts, including the risks of extrapolation as a basis for future estimates, by people who do not know how the data have been compiled and portrayed. Yet the pseudo-scientific atmosphere which the use of charts and statistics created gave great power to the statisticians. Any statistician who was concerned with issues of policy was bound to find himself sooner or later selecting and manipulating statistics in such a way as to guide policy along the lines which he had decided, on quite general grounds, were the right ones. Professor Devons indicates that where planning is necessary, great power must inevitably fall into the hands of the statisticians.

The book concludes with a review of the problems of co-ordination to ensure the best results. Because of shortages decisions had to be taken, for example, to increase the production of one type of aircraft at the expense of another, or to reduce output either of spares or of new aircraft. The co-ordinator had to assess the significance of a large number of factors, but only in general terms, and he had to be continually on guard against succumbing to the temptation of becoming a specialist in one particular sector. He had to realize that all problems of planning are problems in the choice between alternatives, and that to produce more of one product implied a decision to produce less of something else. Ability to use statistics and training in economics were assets. The co-ordinator had to have qualities of personality which enabled him to criticize without irritating, to advise without appearing to interfere, to win the confidence of others, and to find out secrets without appearing to spy. A useful appendix illustrates the intricacies of planning by giving details at a given date (June, 1944) of the complex of factors which had to be considered and the risks involved.

Some of the difficulties encountered in planning aircraft production in time of war would not apply in peace-time planning of the production of aircraft or of other peace-time products. In peace-time new models of products may be held back until surplus stocks can be sold, whereas in war-time the less efficient models must be quickly replaced, and stocks of out-of-date types are largely waste. This book should be read by all who are interested in the organization of war-time production and in its implications for peace-time planning.

J. HENRY RICHARDSON.

1951]

STATISTICAL NOTES

(1) BRITISH OFFICIAL STATISTICS

The interim index of retail prices compiled by the Ministry of Labour and National Service rose from 117 in January to 118 in February, 119 in March and 121 in April. All the groups of items covered by the index, except drink and tobacco, have shown a substantial rise in the last three months as will be seen from the following detailed figures:

(Prices at June 17th, 1947 = 100)

Date	Food	Rent and Rates	Clothing	Fuel and Light	House- hold Durable Goods	Miscel- laneous Goods	Services	Drink and Tobacco	Total
Weights:	348	88	97	65	71	35	79	217	1,000
Jan. 16th, 1951	126.9	101.5	126.0	122.3	120.5	114.3	112.9	104.1	117
Feb. 13th "	127.5	101.5	128.2	125.6	124.3	117.1	113.7	104.1	118
Mar. 13th "	128.0	101.5	130.9	126.3	126.1	119.7	114.4	104.3	119
April 17th "	130.6	103.7	134.2	128.3	127.7	122.6	115.8	104.3	121

In publishing the figures, the Ministry of Labour states that they are in the form in which they are used in the procedure adopted in calculating the index for all the groups combined, i.e., to the nearest first place of decimals. The decimals are shown in order that, if desired, calculations can be made of the effect of combining particular groups and excluding others. The information available as to price changes, however, is such that no precise significance can be attached to the decimals, and for any other purposes, therefore, the figures should be used to the nearest whole number.

The Ministry of Labour index of weekly wage rates which was 114 (June, 1947 = 100) at the end of 1950, rose to 115 in January, 116 in February, 117 in March and 118 in April. At the end of April the index stood at 117 for men, 120 for women and 122 for juveniles. The principal increases this year have affected building workers, lower-paid coal miners, cotton and wool textile operatives, railway employees, dock workers and road passenger transport workers.

The index of average weekly earnings in October, 1950, was 124 (April, 1947 = 100), the figure for men being 122, for women 123 and for juveniles 135. The actual average earnings in the industries covered by the Ministry of Labour enquiries, in October, 1950, was as follows:

	Men	Youths and Boys	Women	Girls	All Workers
Weekly earnings	150s. 5d.	63s. 9d.	82s. 7d.	53s. 5d.	128s. 0d.
Hourly earnings	37.9d.	17.2d.	23.6d.	15.6d.	33.3d.

These averages show increases of 140 per cent. in weekly earnings and 143 per cent. in hourly earnings over October, 1938. The average hours worked in October, 1950, were 46.1. They have shown a gradual rise since April, 1947, when the average was 45.0. The average of 46.1 hours compares with 46.5 in October, 1938, in spite of the fact that there has been a reduction in normal hours from 47 or 48 to 44 or 45.

The total working population and the numbers in civil employment at recent dates, compared with mid-1948, when the new series of man-power figures started, have been as follows:

	Total Working Population			Numbers in Civil Employment		
	Males	Females	Total	Males	Females	Total
Mid - 1948	15,810	7,094	22,904	14,698	6,986	21,684
Dec., 1950	15,921	7,304	23,225	14,964	7,181	22,145
Jan., 1951	15,943	7,306	23,249	14,981	7,185	22,166
Feb., "	15,918	7,296	23,214	14,954	7,179	22,133
March, "	15,918	7,307	23,225	14,954	7,195	22,149

VOL. CXIV. PART II.

188

The level of unemployment which had risen slightly in January fell in the next two months. The figures are analysed below:

*Number of Unemployed Persons on the Registers of the Employment
Exchanges of the Ministry of Labour and National Service*

Date	Men and Boys	Women and Girls	Total
Jan. 15th, 1951	230,864	102,707	333,571
Feb. 12th, „	204,168	97,784	301,952
Mar. 12th, „	182,882	91,979	274,861
April 16th, „	164,908	88,044	252,952

The figures do not include registered severely disabled persons who are unlikely to obtain work other than under special conditions.

It is estimated that the number of unemployed persons on the registers at April 16th represented 1.2 per cent. of the total number of employees insured under the national insurance schemes. The percentages in the various regions ranged from 0.4 in the Midlands and 0.5 in the North Midlands to 2.2 in the Northern Region, 2.6 in Scotland and 2.8 in Wales.

The number of insured persons absent from work owing to sickness, including self-employed as well as employed, rose from 859,900 in December, 1950, to 1,426,600 in January. It then fell to 1,109,100 in February, 973,600 in March and 902,700 in April. The number of employed persons absent owing to industrial injuries was 57,500 in December, 62,000 in January, 58,700 in February, 59,000 in March and 57,400 in April. All these figures were lower than in the corresponding months a year ago.

The *Classification of Occupations* as revised for use in the 1951 Census of Population (General Register Office, H.M.S.O., 1951, 13s. 6d.), leaves no excuse for the confusion hitherto existing between "industry" and "occupation". Both terms are exactly defined, as they are to be used for Census purposes, in the introduction to this publication and illustrative examples are given. In determining the groupings of the many occupations it has been kept in mind that the Census figures will be used in other social investigations.

To achieve the main purpose of providing groups with at least one common characteristic, and to ensure that the Occupational Classification should be complete in itself, it has been necessary to list a very large number of unit groups. These have been further grouped into sub-orders (where desirable) and into twenty-eight main orders, the components of which possess certain broad features in common. Where applicable, the presentation of the major groups has been arranged according to the sequence of the orders of the Standard Industrial Classification.

Each unit group listed bears an occupation code number and a second code number denoting social class. This second type of grouping is intended to provide a convenient arrangement of occupations (not individuals) into five social classes, is based on "general standing within the community", and (except for modifications in detail) follows the general lines adopted in 1921 and 1931. In passing it may be noted that occupation code 805 (Mathematicians, Statisticians, Actuaries and Economists) is allocated to Social Class I, while occupation code 785 (Teachers, among whom would be counted University Lecturers in Statistics) is allotted to Social Class II.

An alphabetical list of occupations makes reference to the appropriate unit group, sub-order and order a simple matter, and the directions to clerks for occupation and industrial status coding should prevent any inconsistency in the classification of specific types of worker.

In *United Kingdom Overseas Investments, 1938-48* (Bank of England, 1950. 2s.), the Bank of England has revised and brought up-to-date the well-known annual estimates of British overseas investment made by Lord Kindersley before the war. Figures are given for 1938 (revising downwards slightly Lord Kindersley's estimate for that year) and each year up to 1948. They show both the *nominal* value of investment and the returns on them in the form of interest and dividends to U.K. residents (or to the Commissioners of Inland Revenue). The estimates are, of course, limited to investment in the form of securities held by U.K. residents in overseas Governments or local authorities, in U.K.-registered companies operating entirely or almost entirely abroad.

1951]

and in overseas-registered companies. They do not include securities in companies operating only in part abroad; they thus exclude, for example, holdings in U.K. insurance and shipping companies which derive a significant proportion of their profits from operations overseas. No estimate is made of other forms of overseas investment nor of U.K. overseas liabilities of any kind.

The estimates of income received are thus very different from (much less than) the estimates of "interest, profits and dividends" received, as shown in the series of official White Papers on the balance of payments. In particular, the Bank's estimates exclude, while the White Papers include, undistributed profits "brought home" by U.K. companies operating abroad; the Bank excludes, and the White Papers include, profits of companies operating partly abroad (except that the White Paper excludes from interest profits and dividends, and brings in, under another heading, the profits earned abroad of U.K. insurance and shipping companies); on the other hand, the Bank includes, but the White Paper brings in under another heading, profits of U.K. oil companies operating abroad.

The Bank's estimates show a decline in the nominal value of the securities covered from £3,545 million in 1938 to £1,960 million in 1948. But the interest and dividends received fell only from £155 million to £116 million over the same period. The average return thus rose from 4.4 per cent. to 5.9 per cent. of the nominal capital value. Indeed the rate of return increased on almost every class of security except Government and local authority loans, the biggest increase being in the return on shares of overseas-registered companies in foreign countries, which rose from 2.3 per cent. to 10.9 per cent. (mainly because although we gave up two-thirds of our holdings in such companies in the U.S.A., the income from the remaining third exceeded the whole income received in 1938). If account is taken of the fall in the long-term interest rate since 1938, it might well be maintained that the capitalized value of our overseas income from securities is little less than it was before the war.

It is to be hoped that the Bank will continue to make these estimates available from year to year.

(2) OTHER STATISTICS

An inquiry into *Agricultural Rents in England and Wales, 1946-47*, has recently been conducted jointly by the Country Landowners' Association and the Ministry of Agriculture, and a Report by Dr. C. V. Dawe of Bristol University has now been issued by the Association (price 4s. 6d. post free). This is in continuation of the report of a previous investigation (1870-1946) which was noted in an earlier issue of this *Journal*, Part II, 1949, p. 231.

The difficulties in the way of obtaining a representative sample of Agricultural Rents are very great and no claim is put forward that the present sample can be regarded as "random" in the statistical sense. It represents, however, about 10 per cent. of the corresponding total agricultural area of England and Wales, and comparison may fairly be made between the figures for 1946 and 1947. The area of the inquiry covered about 2 million acres in 353 estates, of which 1,758,000 acres were agricultural land proper and the remainder moorland and woodland. The changes in gross rent between the two years were on the whole slight, averaging 27s. 5d. in 1946 to 28s. 2d. in 1947, a rise of only 2.9 per cent., and that at a time when farmers' profits were in general rising much more substantially.

A feature of importance is the relation between the gross rent and the expenditure by the landlord on farm maintenance, such as repairs, insurance, and management, as well as statutory charges such as tithes, rates, etc. Outlay of this type was found to amount to 15s. 6d. per acre in 1946 and 18s. 4d. in 1947, a rise of some 20 per cent., representing about 65 per cent. of the gross rent. In addition there is the non-recurring capital expenditure on farmhouses, cottages, buildings, water supplies, drainage, electricity and so forth. The outlay on these improvements was about 6s. per acre in 1946 and 7s. 1d. in 1947. If we combine this with the maintenance and statutory charges we get a total of 25s. 5d. per acre, which is about 90 per cent. of the gross rent of 28s. 2d. per acre. These figures are, of course, averages based on particulars from 353 estates embracing 21,000 separate holdings; naturally there would be wide variation between individual items.

The second edition has been issued of a work which is now well known, *National Income Statistics, 1938-1948* (United Nations, Statistical Office. 17s. 6d. paperbound; 25s. clothbound. Available from H.M.S.O.) It includes a section on conceptual problems which sets out the approaches adopted in different countries to some of the main problems of definition; a summary of the national income statistics for 32 countries (with such figures as are available for a number of other countries); and a critical commentary making the necessary adjustments, wherever possible, to provide internationally comparable statistics. New features of the present volume

are a summary of the social accounts for countries which use this technique in their official publications and an analysis of the available material, so far as possible on a comparable basis, of national income divided by industrial origin and by distributive shares, and of expenditure at market prices by type of expenditure.

The volume does not repeat figures from the previous volume for countries which have published no new data.

The National Income of Greece for the year 1947 (mimeographed) and *National Income and Investment of Greece for the years 1945 to 1949* (revised) (mimeographed), both from Kingdom of Greece, Ministry of Co-ordination, are admirable efforts by the officially established Income and Investment Research Committee to compute the basic national income statistics generally admitted to be necessary for sound economic policy. Attention is rightly concentrated on investment, and the means of financing it, although the latter—in the continental tradition—is seen as a problem of finding specific technical means of financing rather than in the general balance between saving and investment.

Because of the absence of reliable tax assessment data, the Greek statisticians have been obliged to base their national income estimates principally on output data. For agriculture, these consist of crop and livestock estimates in quantities, multiplied by estimated average prices to the producer, less estimated values (similarly computed) of fertilizers, feeding stuffs and other materials used. For industrial production, special data have been collected of the value of gross output, but rough estimates have had to be made of materials, etc., used. For services, however, tax assessment data have been used in part.

The estimates are set out and the methods described in considerable detail, but not enough information is given to enable one to judge the comparative reliability of the several components of the estimates. For example, the valuations applied to farm produce are obviously subject to wide margins of error, but no information is given of the possible variability. Again, the definitions are not always precise. It is not very clear, for example, how far the agricultural output estimates are intended to be total output, how far marketed output. A more trivial example is the encouraging statement that the "artists" together receive a total income three times that of the "journalists and translators"—although some may think it less pleasing that the "teachers" in total receive an income only one-tenth of that of the artists. But one is not told whether "artists" include pavement artists, commercial artists, poster artists, nor whether teachers under the State education system are treated as "teachers" or as "civil servants". Nor is there any indication of the numbers in the various categories to help one to appreciate the significance of the figures.

An attempt is made to compare the main magnitudes in post-war years with 1938, in real terms. But this goes no further than deflating total income and also investment by a retail price index (which has moved from 1 to 200 during the period). The result is to show real net national income 20 per cent. less in 1949 than in 1938. It is doubtful whether any significance at all can be attached to this. Unless a number of special price indexes can be devised, it would appear more useful to draw up output indexes from such quantitative data as are available. Whether such indexes can be appropriately combined to form an index of total output is less important than to show such data as are available for the several components.

CURRENT NOTE

Fellows will have observed with particular interest in the Honours List of June, 1951, the award to the President of the C.B.E. At its meeting in June the Council recorded its congratulations to the President, and all Fellows will wish to be associated with this expression of its pleasure.

1951]

STATISTICAL AND ECONOMIC ARTICLES IN RECENT PERIODICALS

UNITED KINGDOM—

Accounting Research—

January 1951—American reports and accounts—some lessons for British accountants: *J. R. Lane*. Alternative presentations of the social accounts: *H. C. Edey* and *A. T. Peacock*. A diagrammatic representation of standard cost variances: *D. Solomons*. The form of government accounts, I: *A. A. Garrett*. II: *W. B. Reddaway*. Corporate taxation based on replacement cost: *P. Wiles*. The trade cycle meditated anew: *F. Sewell Bray*.

Advancement of Science—

March 1951—Power, its production and distribution: *J. R. Beard*.

Biometrika—

December 1950—A simple stochastic epidemic: *N. T. J. Bailey*. On the Fisher-Behrens test: *M. E. Wise*. On the levels of significance of the incomplete beta function and the F -distributions: *L. A. Aroian*. On the generalized second limit-theorem in the calculus of probabilities: *K. S. Rao* and *D. G. Kendall*. A note on the cumulants of Kendall's S -distribution: *H. Silverstone*. The distribution of the variance ratio in random samples of any size drawn from non-normal universes: *A. K. Gayen*. The comparison of percentages in matched samples: *W. G. Cochran*. The exact partition of χ^2 and its application to the problem of the pooling of small expectations: *H. O. Lancaster*. The use of range in analysis of variance: *H. O. Hartley*. On the comparison of estimators: *N. L. Johnson*. A rapid method for ascertaining serial lag correlation: *G. D. Gibson*. The maximum F -ratio as a short cut test for heterogeneity of variance: *H. O. Hartley*. Tables of the χ^2 integral and of the cumulative Poisson distribution: *H. O. Hartley* and *E. S. Pearson*. On a sequential t -test: *S. Rushton*. Properties of some tests in sequential analysis: *A. G. Baker*. The unbiased estimation of heterogeneous error variances: *A. S. C. Ehrenberg*. Sampling theory of the negative binomial and logarithmic series distributions: *F. J. Anscombe*. On questions raised by the combination of tests based on discontinuous distributions: *E. S. Pearson*. Significance of difference between the means of two non-normal samples: *A. K. Gayen*. Testing for serial correlation in least squares regression: *J. Durbin* and *G. S. Watson*. Distribution of "Student"-Fisher's t in samples from compound normal functions: *H. Hyrenius*. The comparison of pairs of treatments in split-plot experiments: *J. Taylor*. On the best unbiased quadratic estimate of the variance: *H. Nagler*. The cumulants of the first n natural numbers: *A. Stuart*. Note on the χ^2 smooth test: *D. A. S. Fraser*. An alternative form of χ^2 : *F. N. David*. On a theorem concerning the secondary subscripts of deviations in multivariate correlation using Yule's notation: *K. N. Chandler*.

British Journal of Social Medicine—

October 1950—Twinning in twin pedigrees: *J. A. H. Waterhouse*. Congenital malformation of the central nervous system: *R. G. Record* and *T. McKeown*. Observations on all births (23,970) in Birmingham, 1947: *I. J. R. Gibson* and *T. McKeown*. Energy expenditure during 'stepping': *R. Passmore* and *J. G. Thomson*.

British Journal of Sociology—

Vol. I, No. 4—The conception of the middle classes: *G. D. H. Cole*. Studies in the genesis of the naval profession: *N. Elias*. Social class and politics in Greenwich: *M. Benney* and *P. Geiss*. Student selection—an experimental investigation—I: *T. Himmelweit*. Vol. II, No. 1—Villagers in Metropolis: *S. Reimer*. Type of work motivation: *W. Baldamus*. Student selection—II: *H. T. Himmelweit* and *A. Summerfield*.

Chartered Insurance Institute, Journal—

Vol. 47, Part 2—Punched-card mechanization and its application to insurance work: *W. J. A. Hooper*.

Economic Journal—

December 1950—The substitution effect in value theory: *R. G. D. Allen*. The premium on U.S. dollar securities: *M. S. Rix*. Diversification of industry: *J. Sykes*. Economics and the social sciences: *A. G. Papandreou*. Mr. Harrod's dynamic model: *S. S. Alexander*. Some observations on problems of hill and marginal land: *J. M. Ritchie*. Professor Goodwin's matrix multiplier: *J. S. Chipman*. Does the matrix multiplier oscillate?: *R. M. Goodwin*. The pricing of manufactured products: *E. A. G. Robinson*. Measurement of industrial efficiency: *M. M. Mehta*. A further statistical note on the distribution of individual output: *A. D. Roy*.

March 1951—Electricity tariffs in theory and practice: *H. S. Houthakker*. Physiocracy and classicism in Britain: *R. L. Meek*. On making the best of balance of payments restrictions on imports: *J. M. Fleming*. The role of the British Life Assurance Companies in the capital market: *G. Clayton*. European East-West trade and the United Kingdom food supply: *D. B. Halpern*.

Economica—

November 1950—The problem of integrability in utility theory: *P. A. Samuelson*. Uniform cost accounting—a survey. Part II: *D. Solomons*. Real investment in stocks and “inventory profits” in 1948: *A. P. Zentler*. A note on grants in federal countries: *A. D. Scott*. Reparation payments in kind: *Br. Suviranta*. Devaluation and the balance of payments: *A. C. L. Day*. A note on international commodity agreements: *H. Tyszynski*.

February 1951—The London new issue market: *F. W. Paish*. Distribution of earned and investment incomes in the United Kingdom in 1937-38: *E. C. Rhodes*. The authorship of Sir Dudley North's *Discourses on Trade*: *W. Letwin*. The factor and goods markets: *R. Turvey* and *H. Brems*. The theory of effort and welfare economics: *A. E. C. Hare*. A note on the theory of income redistribution: *A. T. Peacock* and *D. Berry*.

Eugenics Review—

January 1951—Colonial medical policy in relation to population growth: *T. H. Davey*. Constitution—mental disease and psychoanalysis: *E. Miller*. Intelligence and family size of college students: *J. Maxwell*.

Geographical Journal—

March 1951—The range of variation of the British climate: *G. Manley*.

Incorporated Statistician—

Vol. I, No. 2 (December 1950)—The Oxford Conference: General Report. Proceedings: Part I. Business statistics: *J. Ryan*. Investigations in random and systematic sampling: *D. J. Finney*. The organization and operation of an industrial statistical department: *D. R. Read*.

Journal of Documentation—

September 1950—A handlist of psychology periodicals in the learned libraries of Great Britain: *J. W. Scott* and *F. V. Smith*.

Lloyds Bank Review—

January 1951—The capital levy: *S. P. Chambers*. The economics of rearmament: *E. A. G. Robinson*. The National Coal Board: *D. Burn*.

Manchester School of Economic and Social Studies—

January 1951—The trend towards economic planning: *G. Myrdal*. The advent of academic economics in England: *S. G. Checkland*. Remedies for localized unemployment: *J. Sykes*. The statistics of absenteeism in coal mining: *S. Moos*.

Oxford University Institute of Statistics, Bulletin—

December 1950—The distribution of capital in private hands in 1936-38 and 1946-47: *K. M. Langley*. Problems of Israel's economy: *A. Hazlewood*.

January 1951—National Income: third quarter of 1950: *D. Seers*, in association with *P. D. Henderson* and *D. G. Holland*. A “human needs” diet in November 1950: *T. Schulz*. Variations in unemployment rates: *C. E. V. Leser*.

1951]

February 1951—The distribution of capital in private hands in 1936–38 and 1946–47 (Par. II): K. M. Langley. The balance of payments and domestic economic policy: T. Balogh.
March 1951—The inappropriateness of simple “elasticity” concepts in the analysis of international trade: T. Balogh and P. P. Streeten. Machinery prices between the wars: H. J. D. Cole. The national income in 1950 and future prospects: D. Seers, in association with P. D. Henderson and D. G. Holland.

Population Studies—

December 1950—Refined rates for infant and childhood mortality: V. G. Valaoras. The cost of children. Parts I and II: A. Henderson. The reproductivity of Jews in Canada, 1940–1942: M. Spiegelman. Birth rate trends and changes in marital fertility in the Netherlands after 1937: T. van den Brink. The intelligence of twins. A comparative study of eleven-year-old twins. II: G. Barclay and J. Maxwell. Geographical planning of international migration: a note on a Franco-Italian project: C. J. Robertson.

Three Banks Review—

December 1950—The essentials for increased productivity: L. H. C. Tippett. The art trade: import and export: C. V. Pilkington. Some reminiscences of Drummonds Bank.

EIRE—

Statistical and Social Inquiry Society of Ireland, Journal—

Vol. XVIII (1949–50)—Financial results on twenty-five farms in Mid-Roscommon in 1948–49: R. O'Connor. Symposium on social security. Marshall Aid: G. A. Duncan. Theory and policy in Anglo-Irish trade relations, 1775–1800: R. D. Collison Black. State enterprises: J. O'Donovan. The Universities, III: J. Meenan.

AUSTRALIA—

The Economic Record—

December 1950—The Budget and the basic wage: C. Clark. Progress report on the trade cycle: T. W. Swan. Investment and immigration in Australia in the 1950's: D. M. Bensusan-Butt. The importance of wool in Australia's national income: S. P. Stevens. The use of theory in history: J. F. Cairns. Employment in New South Wales manufacturing industries, 1877 to 1938–39: H. R. Edwards.

INDIA—

Calcutta Statistical Association Bulletin—

December 1950—A modern approach to the analysis of human behaviour: P. K. Bose. Topographic analysis for a weighted variate: B. Ghosh. Weighing designs: K. S. Banerjee. A note on the income distribution of India and West Bengal: S. Sengupta. Partially balanced designs with two replications: K. R. Nair.

Sankhyā—

November 1950—Completeness, similar regions, and unbiased estimation: E. L. Lehmann and H. Scheffé. The estimation of the mean of a normal tolerance distribution: D. J. Finney. Sequential tests of null hypotheses: C. R. Rao. Some contributions to Hotelling's weighing designs: K. S. Banerjee. A note on the marginal and the optimum size of holding in Bengal: A. Ghosh. A statistical study in multiple cases of disease in households: K. K. Mathen and P. N. Chakraborty. A note on the “Report of an enquiry into the family budgets of middle class employees of the Central Government”: M. Chand. Power function of chi square test with special reference to analysis of blood group data: S. J. Poti.

UNION OF SOUTH AFRICA—

South African Journal of Economics—

December 1950—Some aspects of capital movement, investment and financial liquidity: T. van Waasdijk. The South African railways and the Newton Report: C. S. Richards and J. C. Laight. Family income and expenditure in a Ciskei native reserve: D. Houghton and D. Philcox.

UNITED STATES—

American Academy of Political and Social Science, Annals—
January 1951—Medical care for Americans (whole number).

American Economic Review—

December 1950—Price changes and consumer demand: *G. Ackley* and *D. B. Suits*. Foreign investment and balance of payments: *E. D. Domar*. Stabilization of personal incomes: *P. J. Strayer*. The Soviet price system: *N. Jasny*. The United Kingdom after devaluation: *M. Hall*.

American Economic Review Supplement—

December 1950—The teaching of undergraduate economics. (Whole number.)

American Statistical Association Journal—

December 1950—Who are the unemployed? *P. M. Hauser* and *R. B. Pearl*. Some sampling simplified: *J. W. Tukey*. The effectiveness of quality control charts: *L. A. Aroian* and *H. Levene*. Two-choice selection: *I. Bross*. Operations analysis and the theory of games: an advertising example: *L. Gillman*. Design of experiments for most precise slope estimation or linear extrapolation: *C. Daniel* and *N. Heerema*. Sequential sampling from finite lots when the proportion defective is small: *J. H. Chung*. Correction to "Some new aspects of the application of maximum likelihood to the calculation of the dosage response curve": *J. Cornfield* and *N. Mantel*.

Annals of Mathematical Statistics—

December 1950—The problem of the greater mean: *R. R. Bahadur* and *H. Robbins*. Analysis of extreme values: *W. J. Dixon*. Distribution related to comparison of two means and two regression coefficients: *U. Chand*. The extreme quotient: *E. J. Gumbel* and *R. D. Keeney*. On a preliminary test for pooling mean squares in the analysis of variance: *A. E. Paull*. Estimating the mean and variance of normal populations from singly truncated and doubly truncated samples: *A. C. Cohen, Jr.* The asymptotic properties of estimates of the parameters of a single equation in a complete system of stochastic equations: *T. W. Anderson* and *H. Rubin*. Some nonparametric tests of whether the largest observations of a set are too large or too small: *J. E. Walsh*. On a measure of dependence between two random variables: *N. Blomquist*. Some two sample tests: *D. G. Chapman*. Transformations related to the angular and square root: *M. F. Freeman* and *J. W. Tukey*. Remark on the article "On a class of distributions that approach the normal distribution function" by George B. Dantzig: *T. N. E. Greville*. Independence of quadratic forms in normally correlated variables: *Y. Kawada*.

Bell System Technical Journal—

January 1951—Prediction and entropy of printed English: *C. E. Shannon*.

Biometrics—

December 1950—Gene frequencies in a cline determined by selection and diffusion: *R. A. Fisher*. Problems in the analysis of growth and wear curves: *G. E. P. Box*. Application to reticulocyte blood counts: *M. Schneiderman* and *G. Brecher*. A biometric study of the excretion of corticosteroids in children in relation to age, height and weight: *M. A. Norval* and *N. King*. The evaluation of diagnostic tests: *S. W. Greenhouse* and *N. Mantel*. Estimates of the LD₅₀: a critique: *I. Bross*. The planning of probit assays: *M. J. R. Healy*. Some observations with respect to the error of bio-assay: *J. Berkson*.

Econometrica—

January 1951—The non-linear accelerator and the persistence of business cycles: *R. M. Goodwin*. Consumer substitutions between butter and margarine: *J. M. Morgan*. Equilibrium among spatially separated markets: solution by electric analogue: *S. Enke*.

Harvard Business Review—

January 1951—Current practices in executive compensation: *A. Patton*. How much to spend on advertising: *J. Dean*. Bank stocks at a discount: *R. E. Speagle*. Estimating industrial accident costs: *R. H. Simonds*.

Industrial Quality Control—

November 1950—Changes and corrections for the Hamilton standard lot plot paper. Ford's interest in statistical quality control: *W. H. Smith* and *C. R. Burdick*. A chi-square chart for controlling a set of percentages: *A. J. Duncan*. On the evaluation of raw stock dyeing: *A. G. Klock* and *C. W. Carter*. Quality control in the production of blended whiskey: *D. R. Peryam*. Applying the group chart for X and R: *D. F. Boyd*. Quality control in the forging industry: *D. G. Browne*. The effect of one-sided truncation on the average of a normal distribution: *I. B. Altman*.

January 1951—The three little processes: *O. H. Somers*. Balancing and randomizing in experiments: *W. R. Purcell*. Quality control—a tool for human engineering: *R. Smith*. Application of statistical techniques to the physical testing of plastics: *C. H. Adams*. Some legal aspects of sampling: *F. R. Kennedy*.

Journal of Political Economy—

December 1950—Wesley C. Mitchell as an economic theorist: *M. Friedman*. A theory of income determination: *H. M. Somers*.

February 1951—Foreign economic aid and communism: *C. B. Hoover*. A multiple-country theory of income transfers: *L. A. Metzler*. Group behaviour and international trade: *C. P. Kindleberger*. Efficiency in public-soil-conservation programs: *E. O. Heady*. The Neumann-Morgenstern utility index—an ordinalist view: *W. J. Baumol*.

Mathematical Tables and Other Aids to Computation—

January 1951—High speed sampling: *D. F. Votaw, Jr.*, and *J. A. Rafferty*. Radix table for trigonometric functions and their inverses to high accuracy: *H. E. Salzer*.

Milbank Memorial Fund Quarterly—

January 1951—Medical care among males and females at specific ages—Eastern health district of Baltimore, 1938–1943: *J. Downes* and *E. H. Jackson*. Social and psychological factors affecting fertility. XI. The interrelation of fertility, fertility planning and feeling of economic security: *C. V. Kiser* and *P. K. Whelpton*.

Psychometrika—

December 1950—A superior rotational method in factor analysis for psychometricians in government service: *D. C. Adkins*. Estimation of parameters in a truncated trivariate normal distribution: *D. F. Votaw, J. A. Rafferty* and *W. L. Deemer*. The Johnson-Neyman technique, its theory and applications: *P. O. Johnson* and *L. C. Fay*. The comparability of scores from three mathematics tests of the College Entrance Examination Board: *D. G. Schulz*. On the effect of the cutting score when selection is performed against a dichotomized criterion: *Z. W. Birnbaum*. Maximizing predictive efficiency for a fixed total testing time: *C. W. Taylor*. Predicted differences and differences between predictions: *W. G. Mollenkopf*.

Quarterly Journal of Economics—

November 1950—Alfred Marshall's theory of value: *R. Frisch*. The theory of turning points in business fluctuations: *C. Warburton*. Nationalization in theory and practice: *A. Beacham*. The multiplier, flexible exchanges and international equilibrium: *W. F. Stolper*. Economics and value judgments: *P. Streeten*. The effects of price and wage flexibility: *R. Fels*.

AUSTRIA—

Statistische Vierteljahresschrift—

Vol. III, Parts 3/4—Das Stichprobenverfahren im Dienste von Volkszählungen. I: Einleitende Bemerkungen: *W. Winkler*. II: Stichprobenverfahren bei Bevölkerungserhebungen: *H. Wagner*. III: Zur bayerischen Volks- und Berufszählung: *A. Adam*. Untersuchungen über die Sterblichkeit Wiener Arbeiter und Angestellter in der Nachkriegszeit: *H. Wagner*. Universitätsgeist und Wirtschaftsstatistik: *O. Winkler*. Zur Terminologie einiger Begriffe der naturwissenschaftlichen und der Stichproben-Statistik: *A. Zeller*. Bemerkungen zur Bildstatistik: *W. Winkler*.

BELGIUM—

Bulletin de l'Institut de Recherches Economiques et Sociales—

March 1951—La conjoncture économique de la Belgique: *M. Wotrin*.

BRAZIL—

Revista Brasileira de Estatística—

January-March 1950—O desemprego como fenômeno econômico: *A. Sampaio*. Nota sobre mortalidade infantil: *O. P. Carreiro*. O conceito de densidade em demografia: *J. G. Galé*. Sobre os métodos aplicados para a reconstituição do movimento da população do Brasil, com a ajuda dos dados dos recenseamentos: *G. Mortara*. Contribuição ao “statistical vocabulary”: *L. Câmara*.

FRANCE—

Journal de la Société de Statistique de Paris—

October-December 1950—Définition et évolution de l'inégalité des revenus: *le Baron Mourre*. Sur la notion statistique d'aberrance: *C. Penglaou*. Chronique des statistiques bancaires et des questions monétaires: *P. Cauboue*. Distribution des prix relatifs et conception statistique des nombre indices: *G. Defrance*.

Population—

October-December 1950—“La famille heureuse” ou l'optimum familial: *R. Debré*. Deux enquêtes nationales sur la maternité et sur la santé de l'enfant en Grande-Bretagne: *J. W. B. Douglas*. La population de la région de Youkounkoun en Guinée française: *M. de Lestrangé*. Les recherches américaines sur la mobilité sociale: *N. Rogoff*. La mesure de la consanguinité. Perspectives d'application à la démographie: *L. Tabah* and *J. Sutter*. Une enquête sur les besoins des familles: *A. Girard*.

Revue d'Économie Politique—

September-October 1950—La réforme monétaire de 1948 dans l'Allemagne occidentale: *B. Nogaro*. L'emploi des modèles pour l'élaboration d'une politique économique rationnelle: *R. Frisch*. La notion de l'équilibre chez Joseph Schumpeter: *J. Dumontier*. Contribution à une théorie des fonctions de coût: *M. Verhulst*.

November-December 1950—L'emploi des modèles pour l'élaboration d'une politique économique rationnelle (2^e et 3^e parties): *R. Frisch*. L'explication des mouvements de prix en conjoncture (2^e partie): *A. Vincent*. Une étude d'économie synthétique: le “Modèle” de Leontieff: *P. Maillet*.

GERMANY—

Mitteilungsblatt für Mathematische Statistik—

Vol. 2, Part 3—Die Toleranzbereiche der mittleren quadratischen Abweichung: *U. Graf* and *H. J. Henning*. Logarithmische Normalverteilungen und ihre Anwendungen: *H. Gebelein*. Pascalsche Verteilungen, Confidence- und Fiduzialschluss: *G. Friede*. Konnuptialindex und Korrelationskoeffizient: *K. Rother*. Bemerkungen zur Anwendung statistischer Methoden in der Technik (Schluss): *E. Rossow*. Zum Problem des Wär-metods: *C. F. v. Weizsacker*.

ITALY—

Giornale degli Economisti e Annali di Economia—

September-October 1950—L'Opera scientifica di Gino Borgatta: *A. Scotto*.

November-December 1950—Sulla misura delle progressività strutturale di una imposta: *R. D'Addario*. Convenienza economica collettiva internazionale: *G. la Volpe*.

SWEDEN—

Skandinavisk Aktuarietidskrift—

Vol. 3-4 (1950)—The distribution of the t and z variables in the case of stratified sample with individuals taken from normal parent populations with varying means: *M. Weibull*. A table of percentage points of the χ^2 -Distribution: *A. Hald* and *S. A. Sinkbaek*. Risk theory and group insurance: *K.-G. Hagstrom*. A theorem on translations by Hille, and its interpretation from the point of view of the theory of probability: *L. Dahlgren*. The problem of optimum stratification: *T. Dalenius*. On a property of order statistics from a rectangular distribution: *S. Malmquist*.

1951]

SWITZERLAND—

Schweizerische Zeitschrift für Volkswirtschaft und Statistik—

February 1951—L'évolution de quelques causes de décès importantes en Suisse depuis 1936: R. Sailer. Peut-on indéfiniment élargir le secteur public? L'expérience française: H. Laufenburger. Einige Aspekte der Europäischen Zahlungsunion: R. Frei. Zur "Entfeinerung" der statistischen Aussage und über die Bedeutung der statistischen "Grobzahl": F. Below.

UNITED NATIONS—

Economic Bulletin for Europe—

Vol. 2, No. 2 (October 1950)—The coal and steel industries of Western Europe. Changes in the structure of wages in European countries.

LIST OF ADDITIONS TO THE LIBRARY

Since the issue of Part I, 1951, the Society has received the publications enumerated below.

I.—OFFICIAL PUBLICATIONS

(a) United Kingdom

Agriculture and Fisheries, Ministry of

- Agricultural Improvement Council for England and Wales: second report. London, H.M.S.O., 1950. iv, 26 pp. 9½". 1s.
Farm incomes in England and Wales 1944-45 to 1947-48: a report based on the farm management survey. London, H.M.S.O., 1950. 191 pp. 13". 10s. 6d. (Farm Income Series, 1.)

Commonwealth Economic Committee

- Fruit: a summary of figures of production and trade relating to fresh, canned and dried fruit, and wine. 1950. xv, 116 pp. 9½". 5s.
Industrial fibres: a summary of figures of production trade and consumption relating to cotton, wool, silk, flax, jute, hemp, mohair, coir and rayon ... 1951. xiv, 148 pp. 9½". 5s.
World consumption of wool, 1949: a supplement to Wool Intelligence ... 1950. 167 pp. 13". 5s. London, H.M.S.O.

Defence, Ministry of. Guide to government department and institutional libraries available to J.I.B. London, Joint Intelligence Bureau, 1951. [ii] 59 pp. 13".

Fuel and Power, Ministry of. Statistical digest, 1948 and 1949. London, H.M.S.O., 1950. [ii] 197 pp. 11". 7s. 6d.

General Register Office. Classification of occupations, 1950. London, H.M.S.O., 1951. xii, 317 pp. 13". 13s. 6d.

Medical Research Council. Occupational factors in the aetiology of gastric and duodenal ulcers, with an estimate of their incidence in the general population; by R. Doll and F. A. Jones, with the assistance of M. M. Buckatzsch. London, H.M.S.O., 1951. 96 pp. 9½". 2s. 6d. (Special Report Series 276.)

Overseas Food Corporation. The future of the Overseas Food Corporation. London, H.M.S.O., 1951. Cmd. 8125. 19 pp. 9½". 9d.

Scotland, Department of Agriculture for. Scottish agricultural economics: some studies of current economic conditions in Scottish farming. Volume I. Edinburgh, H.M.S.O., 1950. 57 pp. maps. 9½". 1s. 6d.

Social Survey

A handbook for interviewers; edited by Muriel Harris. London, Central Office of Information, 1950. iii, 134 pp. 8".

The register of electors as a sampling frame; by P. G. Gray, T. Corlett and P. Frankland. London, Central Office of Information, 1950. 21 pp. 13".

Trade, Board of

Exporting to Canada. London, H.M.S.O., 1951. 72 pp. map. 9½". 2s. 6d.

Japan: a review of commercial conditions, April, 1950. London, H.M.S.O., 1950. 31 pp. map. 8½". 1s.

Overseas economic surveys. Southern and Northern Rhodesia and Nyasaland ... Feb., 1950. iv, 92 pp. 2s. 6d. Uruguay ... April, 1950. v, 34 pp. map. 9½". 1s. 6d. London, H.M.S.O., 1950.

Report of the committee on the organization and constitution of the British Standards Institution. London, H.M.S.O., 1950. 43 pp. 9½". 1s.

Transport, Ministry of. London traffic congestion: report by the London and Home Counties Traffic Advisory Committee. London, H.M.S.O., 1951. 56 pp. maps. 9½". 2s.

Works, Ministry of. Productivity in house-building: a pilot sample survey in the South, East, and West of England and in South Wales, August, 1947-October, 1948. London, H.M.S.O., 1950. iv, 27 pp. 9½". 1s. (National Building Studies Special Report, 18.)

Works, Ministry of. Chief Scientific Adviser's Division. An inquiry into accidents in the home. London, Ministry of Works, 1950. iv, 55 pp. tables, diagrams. 13".

(b) Other National and International Publications

Austria

Federal Chancellery. ERP. Central Office. The Austrian investment program 1950/52. Vienna, 1950. 204 pp. 11½".

Belgium

Institut National de Statistique. Recensement général de la population de l'industrie et du commerce au décembre, 1947. Tome II. Recensement des maisons et autres bâtiments. Brussels, 1950. 148 pp. 11½".

Economic Commission for Europe

Transport Division. Annual bulletin of transport statistics, 1949. First year. Geneva, 1950. 57 pp. 11½". (1950, II, E.2.)

Eire

Central Statistics Office. Tables of national income and expenditure, 1938 and 1944-50. Dublin, Stationery Office, 1950. 8 pp. 13". 9d.

Food and Agriculture Organization of the United Nations

Commodity reports. Cocoa. 1950. 23 pp. 12". Fats and Oils, No. 1. 1950. 15 pp., 13 appendices. 11½". Fats and Oils, No. 2. 1950. 15 pp. 12 pp., 11". Grain, 1950. 16 pp. 11". Fibres, No. 1. Wool. 1950. 24 pp. 11½". Fibres, No. 3. Jute. 1950. 22 pp. 11". Meat and Livestock. 1950. 28 pp. 11". Washington, 1950. (London, H.M.S.O.) 1s. 9d. each.

France

Institut National de la Statistique et des Études Économiques. Direction de la Statistique Générale. Recensement général de la population, effectué le 10 mars 1946. Volume VII. Exploitations agricoles. Paris, 1950. lxiv, cclvi pp. [iv] maps. 10½".

Italy

Istituto Centrale di Statistica. Classificazioni delle malattie e cause di morte: deliberate dalla VI conferenza internazionale per la revisione delle nomenclature nosologiche ... Rome, 1951. 274 pp. 8¾". 500 l.

Southern Rhodesia

Central African Statistical Office. Report on the census of population of Southern Rhodesia held on 7th May, 1946. Salisbury. 340 pp. tables, diagrs. 13".

United Nations Organization

Economic and Social Council. Report of the Statistical Commission. Lake Success, 1949. (London, H.M.S.O.) 29 pp. 13". 1s. 6d. (Supp. 6, Official Records: 4th year, 9th session.)

Department of Economic Affairs. World iron ore resources and their utilization, with special reference to the use of iron ores in under-developed areas. Lake Success, 1950. (London, H.M.S.O.) viii, 74 pp. 80c. (1950, II, D.3.)

Department of Social Affairs. Department of Economic Affairs. Demographic yearbook, 1949-50. 2nd issue. Lake Success, 1950. (London, H.M.S.O.) 557 pp. 11½". 45s. (1951, XIII, 1.)

Statistical Office

Statistical papers. Series A. Vol. II, No. 3. Population and vital statistics report. 12 pp. 10½".

— Series C. No. 4. Sample surveys of current interest (Third report). 41 pp. 10½". New York, Statistical Office U.N.O.

Statistical yearbook, 1949-50. Second issue. Lake Success, 1951. (London, H.M.S.O.) 555 pp. 11½". 40s. (1950, xvii, 3.)

II.—AUTHORS AND MISCELLANEOUS

- AFIA: a report on the present position of the apparel and fashion industry prepared as a basis for guiding its future progress. London, Apparel and Fashion Industry's Association, 1950. 112 pp. 8½". 10s. 6d. (Presented by Dr. K. G. Fenelon.)
- ALLCOCK (H. J.) and JONES (J. R.). The nomogram: the theory and practical construction of computation charts ... revised by J. G. L. Michel ... 4th ed. London, Pitman, 1950. x, 238 pp. 8½". 18s.
- AMATO (VITTORIO). Sulle correlazione parziali. *Statistica* (1950), 10, 341-350. 9½".
- ANGLO-AMERICAN COUNCIL ON PRODUCTIVITY. Productivity measurement in British industry: a symposium of papers by authors with first-hand experience of its benefits. London, 1950. [3] 32 pp. 10". 2s.
- ARMITAGE (PETER). A comparison of stratified with unrestricted random sampling from a finite population. *Biometrika*, (1947), 34, 273-280. 10¾".
- and ALLEN (IRENE). Methods of estimating the LD 50 in quantal response data. *J. Hyg. Camb.*, 48 (1950), 298-322.
- BARANKIN (E. W.) and GURLAND (J.). On asymptotically normal efficient estimators: I. *Univ. Calif. Publ. Statist.*, 1 (1951), No. 6, 89-130. Berkeley, Univ. California Press. 10¾". 50c.
- BARGER (HAROLD). The transportation industries, 1889-1946: a study of output employment and productivity. New York, National Bureau of Economic Research, 1951. xvi, 288 pp. 9". \$4. (Publications of the N.B.E.R., 51.)
- BARTLETT (M. S.). The frequency goodness of fit test for probability chains. *Proc. Camb. Phil. Soc.*, 47 (1950), 86-95. 10".
- Periodogram analysis and continuous spectra. *Biometrika*, 37 (1950), 1-16. 10¾".
- Tests of significance in factor analysis. *Brit. J. Psychol. (Statist. Section)*, 3 (1950), 77-86. 9½".
- and KENDALL (DAVID G.). On the use of the characteristic functional in the analysis of some stochastic processes occurring in physics and biology. *Proc. Camb. Phil. Soc.*, 47 (1950), 65-76. 10".
- BERTRAM (D. S.). Studies on the transmission of cotton rat filariasis. II. Factors influencing the efficiency of the vector, *Liponyssus Bacoti* ... with a statistical analysis by P. Armitage. *Ann. Trop. Med. Parasit.*, 44 (1950), 55-83.
- III. A natural method for quantitative transmission and its application to a chemoprophylactic test of some drugs ... with a statistical analysis by P. Armitage. *Ann. Trop. Med. Parasit.*, 44 (1950), 107-123. 9½".
- BIGNALL (J. R.), CLEGG (J. W.), CROFTON (J. W.), and others. Intermittent dosage in the treatment of pulmonary tuberculosis with streptomycin: a report to the Streptomycin in Tuberculosis Committee of the Medical Research Council. *Brit. Med. J.*, 1 (1950), 1224. 18 pp. 8½".
- BOURGEOIS-PICHAT (JEAN). Mesure de la fécondité des populations. Paris, Presses Universitaires de France, 1950. [iv], 150 pp. 9½". 350f. (Institut National d'Études Démographiques. Travaux et documents, 12.)
- BRITISH INSTITUTE OF MANAGEMENT. Indices of productivity [by L. H. C. Tippett]. London, B.I.M., 1949. 36 pp. 9¼". 2s. 6d. (Conference Series 9.)
- BRITTON (D. K.). Principles of valuation of land and farms. Reading, Agricultural Economics Society, 1951. 17 pp. 9¾". 1s. 6d.
- BROMIGE (A.). Settlements and income tax. London, Taxation Publishing Co., 1950. 146 pp. 8½". 15s.
- BRUSSELS. INSTITUT UNIVERSITAIRE D'INFORMATION SOCIALE ET ÉCONOMIQUE. Périodique bimestriel, 1950. No. 3. Jacquemyns (G.). Opinions des Belges au sujet de la loi sur l'alcool, du permis de conduire et de l'assurance obligatoire, des devoirs à domicile, du coût de la vie, du relèvement de l'Allemagne. 45 pp.
- No. 4. Jacquemyns (G.). Le travail de la femme hors du foyer: un sondage d'opinion publique au sujet de son opportunité de sa rémunération et de son organisation. 83 pp.
- No. 5. Opinions des Belges au sujet de la guerre en Corée, du Conseil de l'Europe, de L'Armée européenne, du réarmement de l'Allemagne. 31 pp.
- No. 6. Cinq années de sondages. Questions posées. Principaux résultats. 74 pp. Brussels, INSOC, 1950. 8¾".
- BUTTERBAUGH (GRANT I.). A bibliography of statistical quality control. Supplement. Seattle, Univ. of Washington Press, 1951. 141 pp. 9". \$2.
- CAMBRIDGE UNIVERSITY. DEPARTMENT OF APPLIED ECONOMICS. Reprint series. 27. Household expenditure on food in Holland; by G. Stuvell and S. F. James. *J. R. Statist. Soc.*, A, 113 (1950), 59-80. 9¾".

1951]

- 28. La position de l'économetrie dans la hiérarchie des sciences sociales; by G. Tintner *Rev. Econ. Polit.*, 59 (1949), 634-641. 9½".
- 29. The use of sampling methods in national income statistics and social accounting; by R. Stone, J. E. G. Utting and J. Durbin. *Accounting Research*, 1 (1950), 333-356.
- 30. Replacement cost depreciation; by A. R. Prest. *Accounting Research*, 1 (1950), 385-402.
- 31. The real product of the United Kingdom; by W. B. Reddaway. *Bull. Lond. Camb. Econ. Service*, 28 (1950), 79-84.
- 32. A statistical demand function for food in the U.S.A.; by James Tobin. *J. R. Statist. Soc., A*, 113 (1950), 8-149. 9¾".
- 33. Les équivalents à la somme de transactions; by J. Durbin. *Econ. Appl.*, 3 (1950), 165-172. 8¾".
- 34. Some formal relations in multivariate analysis; by G. Tintner. *J. R. Statist. Soc., B*, 12 (1950), 95-101. 9¾".
- 35. The distribution of earnings and of individual output; by A. D. Roy. *Econ. J.*, 60 (1950), 399-505. 9¾".
- 36. Testing for serial correlation in least squares regression, I; by J. Durbin and G. S. Watson. *Biometrika*, 37 (1950), 409-428. 10¾".
- CAMPBELL (W. A. B.), CHEESEMAN (E. A.) and KILPATRICK (A. W.). The effects of neonatal asphyxia on physical and mental development. *Arch. Diseases Childhood*, 25 (1950), 124.
- CHANG (TSE CHUN). Cyclical movement in the balance of payments. Cambridge University Press, 1951. x, 224 pp. 8½". 18s.
- CHEESEMAN (E. A.). Cancer mortality in Northern Ireland. *Ulster Med. J.*, 19 (1950), 19 pp. 9½".
- CLARK (COLIN). The conditions of economic progress ... 2nd ed. London, Macmillan, 1951. xv, 584 pp. 8½". 50s.
- CLEATOR (P. E.). The periodic problem. [Liverpool, Daily Post Printers, priv. print.] 1950. 32 pp. 9".
- CROSS (K. W.). The respiratory rate and ventilation in the new-born baby ... *J. Physiol.*, 109 (1949), 459-474. 9".
- DAW (RAYMOND HANSELL). The trend of mortality from tuberculosis. *J. Inst. Actu.*, 77 (1950), 143-151. 8¾".
- DALENIUS (TORE). Bibliography on sampling ... 2nd ed. Stockholm, Statistical Office of the Swedish Employers' Conference, 1950. 37 pp. 11¾".
- Technik und Methode der Stichprobenerhebungen ... Munich, Bayerische Statistische Landesamt, 1950. ii, 101 pp. 11¾".
- DOLL RICHARD) and HILL (A. BRADFORD). Smoking and carcinoma of the lung; preliminary report ... *Brit. Med. J.*, 2 (1950), 739. 27 pp. 8½".
- FEIGENBAUM (A. V.). Quality control: principles, practice, and administration: an industrial management tool for improving product quality and design and for reducing operating costs and losses ... New York and London, McGraw-Hill, 1951. xi, 442 pp. 9". 59s. 6d.
- FISHER (RONALD ALYMER). Statistical methods for research workers ... 11th ed. Edinburgh and London, Oliver & Boyd, 1950. xv, 354 pp. 8¾". 16s.
- FORTET (ROBERT). Centre National de la Recherche Scientifique. A. Application des théories mathématiques. I. Calcul des probabilités; par Robert Fortet. Paris. C.N.R.S., 1950 (London, H. K. Lewis). 330 pp. 9¼". 27s.
- FRUMKIN (GRZEGORZ). Pre-war and post-war trends in manpower of European countries. *Population Stud.*, 4 (1950), 209-240. 9¾".
- GINI (CORRADO). Aree e centri culturali. *Genus*, 6-8 (1943-49), 103 pp. 9¼".
- Dati e osservazioni sulla selezione naturale nella specie umana. Convegno dedicato I recenti contributi della Genetica Umana alla Medicina. Milano 16 e 17 Settembre, 1949. 14 pp. 10".
- The distribution of stature is hypernormal. *Acta Genetica Statist. Med.*, 1 (1950), 361-376. 9½".
- Economy and sociology. *Banca Nat. Lavoro Quart. Rev.*, (1950), 3-24. 11".
- La popolazione mondiale, il suo sviluppo, il suo sistema di redditi e di consumi. Estratto dal volume *Popolazione e sussistenze nel mondo odierno*. Padua, 1951. 11 pp. 9¼".
- GLOVER (K. F.). Capital formation in inland transport and some of the influences affecting it: estimates of expenditure on roads, road vehicles, railways, permanent way and rolling stock, and a consideration of the influences affecting the size and course of these series, including government policy and the trend of costs. Read before the Study Section of the Royal Statistical Society, Feb., 1950. 10 pp. (Typewritten mss.) 13".

- GROSS (HERMANN). Further facts and figures relating to the deconcentration of the I.G. Farbenindustrie Aktiengesellschaft. Kiel, Institut für Weltwirtschaft, 1950. 60 pp. 1st supplement 12 pp. 2nd supplement 12 pp. Tables. 11½".
- HARROD (R. F.). The life of John Maynard Keynes ... London, Macmillan, 1951. xvi, 674 pp. 9¾". 25s.
- HEECKT (HUGO). Stukturwandlungen und Nachkriegsprobleme der Wirtschaft Norwegens. Kiel, 1950. v, 43 pp. tables. 8¼". (Kieler Studien 8.)
- HERCHENRODER (M. V. M.). Sugar crop forecasting in Mauritius. 9 pp. (Typewritten.) 13". (Conference of Colonial Government Statisticians, Agricultural statistics and food supplies: V. Crop forecasting techniques.)
- HERLEMANN (HANS-HEINRICH). Die Versorgung der westdeutschen Landwirtschaft mit Mineraldünger. Kiel, 1950. 74 pp. tables, diagrs. 8¼".
- HILL (A. BRADFORD) and KNOWELDEN (J.). Inoculation and poliomyelitis: a statistical investigation in England and Wales in 1949. *Brit. Med. J.*, 2 (1950). 16 pp. 8".
- HUGHES (HARRY M.). Estimation of the variance of the bivariate normal distribution. *Univ. Calif. Publ. Statist.*, 1 (1949), No. 4, 37-52. 10½". Berkeley, Univ. of California Press, 1949. 50c.
- ILLINGWORTH (R. S.), HARVEY (C. C.) and JOWETT (G. H.). The relation of birth weight to physical growth. *Arch. Disease Childhood*, 25 (1950), 380-388. 9¾".
- IPPOLITO (GIOACCHINO D'). On the congruence of exchange rates under a system of bilateral trade (with comments by Prof. Bresciani-Turroni and Prof. C. Gini). *Banca Nazionale Lavoro Quart. Rev.* (1950), 3-17. 11".
- IRWIN (J. O.), ARMITAGE (P.), and DAVIES (C. N.). Overlapping of dust particles on a sampling plate. *Nature*, 163 (1949), 809. 8½".
- JEANNENEY (JEAN MARCEL) and COLLIARD (CLAUDE ALBERT). Économie et droit de l'électricité. Paris, Éditions Domat Montchrestien, 276 pp. 10½".
- JENSEN (ARNE). Moe's principle: and econometric investigation intended as an aid in dimensioning and managing telephone plant: theory and tables ... Copenhagen Telephone Company, 1950. 158 pp. 10".
- JOWETT (G. H.), PRICE (P. H.) and SARJANT (R. J.). An investigation into the relations between Gray-King assay, crucible swelling number, and percentages of hydrogen and carbon in South Yorkshire coals. *J. Inst. Fuel* (1950). 4 pp. 12".
- LANCASTER (HENRY OLIVER). The combination of probabilities arising from data in discrete distributions. *Biometrika*, 36 (1949), 370-382. 10¾".
- The derivation and partition of χ^2 in certain discrete distributions. *Biometrika*, 36 (1949), 117-129. 10¾".
- The sex ratios in sibships with special reference to Geissler's data. *Ann. Eugen.*, 15 (1950), 153-158. 10¾".
- Tuberculosis mortality in Australia 1908 to 1945. *Med. J. Australia*, 1 (1950), 655. 8 pp. 11".
- Tuberculosis mortality of childhood in Australia. *Med. J. Australia*, 1 (1950), 760. 8 pp. 11".
- LANCASTER (H. O.) and MADDOX (J. KEMPSON). Diabetic mortality in Australia. *Med. J. Australia*, 1 (1950), 317. 8 pp. 11".
- and WILLCOCKS (W. J.). Mortality in Australia: population and mortality data. *Med. J. Australia*, 1 (1950), 613. 8 pp. 11".
- LONDON SCHOOL OF ECONOMICS REPRINT SERIES OF DIVISION OF RESEARCH TECHNIQUES. No. 1. The statistical approach; by M. G. Kendall. *Economica*, 17 (1950), 127-145. 9".
- No. 2. The law of the cubic proportion in election results; by M. G. Kendall and A. Stuart. *Brit. J. Sociol.*, 1 (1950), 1-14. 8½".
- No. 3. Factor analysis; by M. G. Kendall and B. Babington Smith. *J. R. Statist. Soc.*, B, 12 (1950), 60-94. 9½".
- LORRIMAN (GERARD) and MARTIN (W. J.). Trial of antistin in the common cold. *Brit. Med. J.*, 2 (1950), 430. 5 pp. 8½".
- LUBIN (ARDIE). Linear and non-linear discriminating functions. *Brit. J. Psychol. (Statist. Section)*, 3 (1950), 88-103. 9½".
- A note on "Criterion analysis". *Psychol. Rev.*, 57 (1950), 54-57. 9½".
- THE MANCHESTER JOINT RESEARCH COUNCIL. Operational research: its application to peacetime industry. Manchester. 151 pp. 9". 10s. 6d.
- MATHER (K.). Statistical analysis in biology ... 3rd ed. London, Methuen, 1949. [iv], 267 pp. 8½". 16s.

1951]

- MORGAN (E. VICTOR). The study of prices and the value of money. London, The Historical Association (George Philip), 1950. 27 pp. table. 7½". 2s. 6d. (Helps for Students of History, 53.)
- MORGENSTERN (OSKAR). On the accuracy of economic observations ... Princeton, University Press, 1950. (London, Geoffrey Cumberlege.) 101 pp. 10". 13s. 6d.
- MUNROE (M. E.). Theory of probability. New York and London, McGraw-Hill, 1951. viii, 213 pp. 9". 38s. 6d.
- NEUMAN (A. M. DE). Consumers' representation in the public sector of industry. Cambridge, Students' Bookshop, 1950. 22 pp. 8½". 3s.
- NOVICK (MARY B.) and HERNANDEZ MENDEZ (VICTOR R.). Statistical graphic presentation. Puerto Rico, School of Public Administration. University of Puerto Rico, 1949. 60 pp. 11".
- PARKINSON (HARGREAVES). Ownership in industry. London, Eyre & Spottiswoode, 1951. x, 129 pp. 9½". 25s.
- PARTEN (MILDRED B.). Surveys, polls, and samples: practical procedures. New York, Harper, 1950. xii, 1, 624 pp. 8½". \$5.
- PEARCE (S. C.). The interpretation of uniformity trials. *A. R. East Malling Res. Stat.*, 1949, (1950), 91-92 pp. 9½". 3d.
- and TAYLOR (J.). The purpose and design of calibration trials. *A. R. East Malling Res. Stat.*, 1949 (1950), 82-90 pp. 9½". 10d.
- PIGOU (ARTHUR C.). Keynes' "General theory": a retrospective view. London, Macmillan, 1950. viii, 69 pp. 7½". 6s.
- PIZZI (MARIO). Sampling variation of the fifty per cent. end-point, determined by the Reed-Muench (Behrens) method. *Human Biology*, 22 (1950), 151-190 pp. 9".
- PROCEEDINGS OF THE SEVENTH INTERNATIONAL CONFERENCE OF AGRICULTURAL ECONOMISTS held at Villa delle Azalee Stresa, Italy, 21-27 August, 1949. London, Geoffrey Cumberlege, O.U.P., 1950. xiv, 327 pp. 9". 25s.
- QUIN (C. E.), MASON (R. M.) and KNOWELDEN (J.). Clinical assessment of rapidity acting agents in rheumatoid arthritis. *Brit. Med. J.*, 2 (1950), 810. 12 pp. 8½".
- RAINICH (G. Y.). Mathematics of relativity. New York, John Wiley (London, Chapman & Hall), 1950. vii, 173 pp. 9". 28s.
- RESERVE BANK OF INDIA. Report of the census of India's foreign liabilities and assets as on 30th June, 1948. Bombay, 1950. 291 pp. 9½". 7s. 6d.
- RIGGLEMAN (JOHN R.) and FRISBEE (IRA N.). Business statistics. 2nd ed. New York and London, McGraw-Hill, 1938. xix, 790 pp. 9". 40s. 6d.
- RAO (C. RADHAKRISHNA). Note on a problem of Ragnar Frisch. *Econometrica*, 15 (1947), 245-249. 10".
- On locally most powerful tests when alternatives are one-sided. On the most efficient designs in weighing. *Sankhyā*, 7 (1946), 439-440. 11½".
- The theory of fractional replication in factorial experiments. *Sankhyā*, 10 (1950), 81-86. 11½".
- Confounded factorial designs in quasi-latin squares. *Sankhyā*, 7 (1946), 295-304. 11½".
- Generalization of Markoff's theorem and tests of linear hypotheses. *Sankhyā*, 7 (1945), 9-18. 11½".
- On the linear combination of observations and the general theory of least squares. *Sankhyā*, 7 (1946), 237-256. 11½".
- Tests of significance in multivariate analysis. *Biometrika*, 35 (1948), 58-79 pp. 10".
- Tests with discriminant functions in multivariate analysis. *Sankhyā*, 7 (1946), 407-414. 11½".
- General methods of analysis for incomplete block designs. *J. Amer. Statist. Assoc.*, 42 (1947), 541-561. 9½".
- On some problems arising out of discrimination with some multiple characters. *Sankhyā*, 9 (1949), 343-366. 11½".
- Statistical inference applied to classificatory problems. *Sankhyā*, 10 (1950), 229-256. 11½".
- A note on the distribution of $D^2_{p+q} - D_p^2$ and some computational aspects of D^2 statistic and discriminant function. *Sankhyā*, 10 (1950), 257-268. 11½".
- On a formula for the prediction of cranial capacity. *Biometrics*, 14 (1948), 245-253. 9½".
- ROBINSON (H. F.) and WATSON (G. S.). An analysis of simple and triple rectangular lattice designs. *N.C. Agric. Exper. Stat. Tech. Bul.*, 88 (1949). 56 pp. 9".
- SCHROCK (EDWARD M.). Quality control and statistical methods. New York, Reinhold, 1950. (London, Chapman & Hall.) xi, 223 pp. 9". 40s.

- SEGERDAHL (CARL OTTO). On homogeneous random processes and collective risk theory. Uppsala, Almqvist & Wiksells Boktryckeri, 1939. 132 pp. 9". 17s. 6d.
- SHARP (IAN G.). Industrial conciliation and arbitration in Great Britain. London, Allen & Unwin, 1950. [x], 466 pp. 8½". 25s.
- SMITH (H. FAIRFIELD). Comparison of agricultural and nurser plots in variety experiments. *J. Council Sci. Indust. Res. Canberra*, 9 (1936), 207-210. 9½".
- Error variance of treatment contrasts in an experiment with missing observations (with special reference to incomplete Latin squares). *J. Indian Soc. Agric. Statist.*, 2 (1950), 111-124. 9¾".
- Estimating precision of measuring instruments. *J. Amer. Statist. Assoc.*, 45 (1950), 447-451. 9½".
- Reversion of selected strains of a wheat variety. *J. Council Sci. Indust. Res. Canberra*, 8 (1935), 1.
- STATISTICAL AND SOCIAL INQUIRY OF IRELAND. Centenary 1847-1947. Proceedings 6th-9th October, 1947. Dublin [1950]. 80 pp. 9½".
- STONE (RICHARD). The role of measurement in economics; by Richard Stone ... the New-march Lectures, 1948-1949, given at University College, London. Cambridge University Press, 1951. viii, 85 pp. 9½". 12s. 6d. (University of Cambridge Dept. of Applied Economics Monograph, 3.)
- TAYLOR (J.). A valid restriction of randomization for certain field experiments. *J. Agric. Sci.*, 39 (1949), 303-308. 10¼".
- The comparison of pairs of treatments in slit-plot experiments. *Biometrika*, 37 (1950), 443-444. 10¾".
- TURNBULL (H. W.) and AITKEN (A. C.). An introduction to the theory of canonical matrices. London, Blackie, 1950. xiii, 192 pp. 8½". 20s.
- VACCHINI (ALFREDO). L'Institut Central de Statistique d'Italie. *Rev. Int. Sci. Adm. Nouv. Brussels*, 3-4 (1949), 30 pp. 9½".
- VANCE (LAWRENCE L.). Scientific method for auditing: applications of statistical sampling theory to auditing procedure. Berkeley, University of California Press, 1950. (London, Cambridge University Press.) xii, 108 pp. 9½". 19s.
- WHITTLE (PETER). Hypothesis testing in time series analysis. Uppsala, Almqvist & Wiksells Boktryckeri, 1951. 121 pp. 9½".
- WHITWORTH (WILLIAM ALLEN). DCC exercises, including hints for the solution of all the questions in Choice and Chance ... New York, G. E. Stechert, 1945. xlii, 237 pp. 7".
- WILLIAMS (E. J.). Confounding and fractional replication in factorial experiments. *J. Australian Inst. Agric. Sci.*, 15 (1949), 145-152. 9¾".

Journal of the Royal Statistical Society

SERIES A (GENERAL)

PART III, 1951.

A COMPARISON OF THE TRENDS OF MALE AND FEMALE MORTALITY

By W. J. MARTIN

*Medical Research Council's Statistical Research Unit, London School of Hygiene
and Tropical Medicine.*

[Read before the ROYAL STATISTICAL SOCIETY, March 28th, 1951, the President,
Professor A. BRADFORD HILL, D.Sc., Ph.D., in the Chair]

1. Introduction

A WELL-KNOWN feature of the mortality experience of England and Wales during the past 100 years is the higher death rate among males than among females. This sex difference seems to be of a permanent nature, and it is not peculiar to this country, nor to any particular set of living conditions that is known to affect the general death rate. A satisfactory explanation has not been found for the male excess in the general rate, although for some causes of death a part of the difference between the sexes can be ascribed to occupational hazards, physiological factors or social habits.

The best-known examples of these three factors are pneumoconiosis and other occupational diseases of the lung, diseases of the thyroid and parathyroid glands, and diseases in which previous indulgence in alcohol affects the prognosis. The second group shows an excess of female, the first and third an excess of male mortality. An example from the third group is pneumonia, where the higher male mortality in adult life was probably due to the larger proportion of heavy drinkers among men. If only a small proportion of men are subject to a heavily increased risk, a large increase in the mortality sex ratio is produced. During the last and in the early years of the present century, when the range of employment available to women was restricted, occupational risk was thought to account for a large part of the sex difference. However, the large increase in the proportion of women engaged in industry in recent years has not, as far as can be ascertained, affected the mortality sex ratio.

During the past hundred years the death rate in England and Wales has undergone considerable changes. The rapid growth in the urban population favoured a high mortality, particularly in the first part of the nineteenth century, when housing and sanitary conditions in the large cities were very bad. The evils of urbanization have been greatly reduced by the reforms in housing and sanitation that followed the enforcement of the law relating to the Public Health Act of 1875, which marked a new era in preventive medicine on the environmental side, and the subsequent

gradual extension to a vast national policy of housing reform and town planning; the decline in mortality has been mainly due to the gradual improvement in general living conditions. Mortality commenced to fall around 1870, and by the end of the following 70 years the death rate had been reduced to one-half of its former level. Several causes of death have now virtually disappeared, among them cholera, smallpox, typhus, simple and ill-defined fever. The last outbreaks of cholera were in 1849, 1854 and 1866, when the deaths amounted to 53,273, 20,097 and 14,378. The last heavy visitation of smallpox in 1871-2 caused 42,084 deaths. Typhus was not tabulated separately until 1869, when 4,281 deaths were attributed to this disease; by 1890 the number of deaths had declined to 151. During the same period the deaths from simple and ill-defined fever fell from 5,310 to 361.

An interesting feature of the excess of male over female mortality, throughout the 100 years covered by the returns of the Registrar-General, is its relatively steady increase during the century. In 1841-45 the age adjusted male mortality was 9.6 per cent. higher than the female, while in 1931-35 it was 27.6 per cent. higher. The crude death rate for males and females and the sex ratio of the age adjusted death rates are shown in Table 1 (p. 296), in quinquennial periods, for the last 100 years. The ratio of male to female mortality shows a continuous increase, although the continuity of the increase was interrupted in the quinquennia containing the war years, when the withdrawal of a large number of men from the civilian population adversely affected the male death rate.

Two important factors which influence mortality, the occupational risk and the risk due to social and environmental conditions, exert different pressure in the two sexes. If females are more affected by home environment than males, then improvement of living conditions might be expected to lower the mortality more for females than for males. Although this hypothesis seems a plausible explanation of the relatively greater decline in female mortality during the nineteenth century, it cannot explain its continuance until now. During the present century, particularly in the past two decades, conditions of work have improved, hours of work have been curtailed, and many of the gross industrial risks have been minimized. It would be expected that any improvement in conditions of work would affect males more than females, yet the female death rate has continued to decline faster than the male; in fact the relative rate of decline has tended to increase during recent years. The difference between the ratio of male to female mortality at the beginning and end of the second 50 years was four times the difference between the ratios at the beginning and end of the first 50 years.

The effect of the differential fall in mortality on the length of life of males and females can best be illustrated by comparing life tables at the beginning and end of the period. The expectation of life at birth from the English Life Table No. 2 (1838-44) was 40.36 years for males and 42.04 for females, and from Life Table No. 10 (1930-32) it was 58.74 for males and 62.88 for females, an increase of 18.38 years (46 per cent.) for males and 20.84 (50 per cent.) for females. The rise in the expectation of life continued to a higher age for females than for males. The expectation of life at age 70 was 8.55 for males and 9.12 for females at the beginning of the period, and 8.67 for males and 10.42 for females at the end of the period. While the average length of life for males aged 70 had only increased by one-eighth of a year, the females had gained one and a third years.

The standardized death rate for both males and females has steadily fallen during recent years but there have been considerable differences in the rate of decline between various causes of death. Owing to large annual fluctuations in the number of deaths a concise and exact description of the trend of a series of rates over a period of years is difficult. A further difficulty is the change in classification made from time to time. Generally it is not possible to convert one form of classification into another. The adoption in 1940 of the physicians' preference when more than one disease was present also caused a complete break in the continuity of mortality statistics. A general picture of the course of mortality over a short period can be obtained by fitting curves and comparing the smoothed trends. For this purpose the standardized death rates per 10,000, for all ages, for the period 1921-39 were fitted, by curves of the form $S.D.R. = Ce^{At}$ with the origin at 1921. This was done by calculating the regression of $\log. S.D.R.$ on time. The curves obtained, while they are not good fits in the statistical sense, give a good description of the trends of the standardized death rates for comparative purposes. The constants of the curves for the most important causes of death were:

1951]

Cause of Death	Males		Females	
	C.	A.	C.	A.
Diseases of the respiratory system	24.4	-0.0443	18.0	-0.0490
Tuberculosis (all forms)	12.9	-0.0343	10.8	-0.0399
Heart diseases	11.8	+0.0367	11.4	+0.0248
Cancer and tumours	9.8	+0.0057	9.9	-0.0017
Diseases of digestive system	8.5	-0.0200	6.6	-0.0264
Violence	6.3	+0.0075	2.3	+0.0153
Other causes	52.7	-0.0205	44.7	-0.0205
All causes	124.0	-0.0126	103.0	-0.0163

In every group the standardized death rate was higher for males than for females at the beginning of the period, except in cancer, where the sexes had an approximately equal death rate. For diseases of the respiratory system, tuberculosis, diseases of the digestive system and for all causes, the rate of decline in mortality was greater for females than for males. The cancer death rate declined slowly for females but increased for males during the twenty years. The death rates from heart disease and violence increased during the twenty years; that from heart diseases increased faster among males than among females, but the rate of increase in the death rate from violence has been twice as great among females as among males.

2. Regional Comparisons

The death rate varies in the different regions of the country. Other factors which are associated with mortality, e.g., housing, occupational and social class distributions, also differ. For this reason the trends of the ratio of male to female mortality for regions was found and the results are shown in Table 2. For convenience the regions as defined in the early reports of the Registrar-General were used, they included: South-Eastern Region (Surrey, Kent, Sussex, Hampshire, Berkshire); South Midland Region (Middlesex, Hertfordshire, Buckinghamshire, Oxfordshire, Northamptonshire, Huntingdonshire, Bedfordshire, Cambridgeshire); Eastern Region (Essex, Suffolk, Norfolk); South-Western Region (Wiltshire, Dorsetshire, Devonshire, Cornwall, Somersetshire); West Midland Region (Gloucestershire, Herefordshire, Shropshire, Staffordshire, Worcestershire, Warwickshire); North Midland Region (Leicestershire, Rutland, Lincolnshire, Nottinghamshire, Derbyshire); North-Western Region (Cheshire, Lancashire); Northern Region (Durham, Northumberland, Cumberland, Westmorland). The quinquennia including the war years have been omitted from this table, partly because the war disturbed the trend of the ratio, as was shown in Table 1, and partly because of the uncertainty that must be attached to estimates of the regional male population of military age. The increase in the ratio of male to female mortality within the regions of Table 2 does not form such a regular progression as was found for the ratio in the country as a whole. The level and rate of increase varied between the regions, the ratio was higher, throughout the period, in London than elsewhere, the difference between the highest and lowest ratio of a region was greatest in the south-eastern region, while in the northern region and Wales the ratio showed the least change. A possible explanation of the higher level of the London ratios is that of female migration. The ratio of female to male population was greater in London than elsewhere in the country, due to large numbers of women who came from the provinces to work in the Metropolis. These were most probably more healthy women who had a lower death rate. If this is true we should also expect that, in regions from which the females emigrated, the ratio of male to female death rates would be lowest. The industrial areas of the north of England and the coal-mining districts of Wales offered only very restricted opportunities for female labour, and women had to seek work in other areas. In these two regions the ratio of females to males was lower than in the other regions. Table 2 shows that the ratio of the standardized male death rate to that of the females remained at almost a constant level until 1921-25 in these two divisions, while the difference between the highest and lowest ratios was smaller in these regions than in the others. This gives support to the theory that the level of the ratio within the regions was influenced by the movement of the female population. To establish it as a fact is, however, rather difficult, since males also migrated. Further, the trend of migration, which was to the north in the first part of the period, has been reversed in

recent years; the counties surrounding London had the greatest rate of increase at the end of the period. A comparison of the rate of growth of the regional population, the average sex ratio and the average standardized mortality sex ratio is:

	Percentage Rate of Increase of Population		Average of Standardized Mortality Sex Ratios	Average Sex Ratio (1841-1931)
	1841-1901	1901-1931		
London	2.42	0.97	124	114
South-eastern	2.19	1.38	117	109
South Midland	1.91	1.55	114	108
Eastern	1.76	1.41	113	105
South-western	1.10	1.08	115	110
West Midland	1.91	1.23	117	106
North Midland	1.82	1.30	111	104
North-western	2.54	1.17	116	108
Yorkshire	2.26	1.22	115	105
Northern	2.63	1.21	113	100
Wales	1.93	1.29	110	99
England and Wales	2.04	1.23	117	107

The regional distribution of the mortality sex ratios of Table 2 provides no evidence that the increase in the ratio for the whole country was due to any particular region, but suggests that this phenomenon was common throughout all areas, although the size of the increase varied.

3. Specific Age Comparisons

The male age-specific death rates expressed as a percentage of the corresponding female rates are shown in Table 3. As would be expected, the trend of the ratio for ages 20-45 was disturbed in the war periods. An increase in the mortality ratio is shown by each age group, although the rate of increase differs considerably from one group to another. The trend of the mortality ratio for the two age groups 5-9 and 10-14 differ from the others by exhibiting a decline in the middle of the period while the others show a fairly continuous rise. The increase in the mortality ratio rose progressively during the years of working life and then declined. The differences between the highest and lowest ratios, omitting the war years, may be taken as measures of the increase. For the eight age groups from age 20 these are 18, 21, 33, 34, 41, 25, 22, 11. The largest ratios occur between the ages of 35 and 65; and this suggests that the occupational risk among males may be a factor of importance.

3.1. Childhood

Ages 0-1.—The ratio of male to female infant mortality was at a constant level during the first 60 years of the period; it then rose during the first five quinquennia of this century and remained almost stationary. The rise in the mortality ratio started at the same time as the fall in infant mortality. The increase in the ratio, although small, is interesting. On the average baby boys have the same environment as baby girls; circumstances that may have a differential effect on male and female adult mortality play no part in the difference between the sexes in infancy. Modifications in the classification of causes of death, made to meet the increase in medical knowledge, make it impossible to trace the course of individual diseases throughout the century, but the rise in the mortality ratio appears to occur for most causes of death. This may be illustrated by dividing the deaths of infants during 1931-40 into five broad groups of diseases—diseases peculiar to early infancy, congenital malformations, pneumonia and bronchitis, diarrhoea, and other causes—containing 43, 10, 19, 9 and 18 per cent. of the total infant deaths. In these groups the percentage ratio of male to female mortality was 131, 119, 131, 135 and 129. Each group, with the exception of congenital malformations, had a ratio in excess of that for all causes during the first 60 years of the period. The death rate from congenital causes and the corresponding mortality sex ratio have been practically constant for the latter part of the period, when infant mortality was declining fast.

1951]

The size of the mortality sex ratio seems to be some function of the size of the infant mortality. This is also suggested by the ratios of male to female infant mortalities by social class. The rates for the two available periods are:

Social Class	1920-2		1930-2	
	Infant Mortality	Male Mortality as a Percentage of Female	Infant Mortality	Male Mortality as a Percentage of Female
I	38	142	33	140
II	55	131	45	136
III	77	132	58	133
IV	89	126	67	129
V	97	128	77	131

There is not a perfect negative correlation, but the lowest infant mortalities have the highest mortality ratios.

Ages 0-5.—The death rates in this age group were dominated by the infant mortality. Deaths of infants under one year of age formed a little more than half of the deaths in this age group at the beginning of the period; owing to the relatively smaller decrease in mortality during the first year of life they had risen to 80 per cent. of the total deaths during the last years of the period. The mortality sex ratio during the first 70 years was practically constant, but rose slightly during the latter part of the period, when there was a continuous decline in mortality; the persons death rate in 1861-65 was 69.1, and in 1906-10 it was 41.7 per 1,000, a reduction of 40 per cent. A comparison of the ratio of male to female death rates from the chief causes of death immediately preceding the rise in the mortality ratio and during recent years is:

	Mortality Sex Ratio	
	1901-10	1940-47
Measles, scarlet fever, whooping-cough and diphtheria	96	90
Diarrhoea and enteritis	118	139
Pneumonia and bronchitis	121	125
Tuberculosis	119	114
Violence	116	128
Other causes	128	131

The smallest ratios in 1940-47 were those of the common infectious diseases of childhood, and tuberculosis. During the period the relative importance of these diseases had fallen from 14 and 6.3 per cent. of all deaths to 5 and 3.3 respectively. The largest increases in the percentage mortality sex ratio were those of diarrhoea and enteritis, and violence. Deaths from the former cause, as a percentage of all causes, declined from 13 to 9, while those from violence increased from 2.5 to 5.6 per cent. The influence of these two causes of death on the total mortality ratio for ages 0-5 was small. Mortality from accidents and negligence at ages under 1, which fell rapidly during the first 40 years of the present century, has risen appreciably during recent years. A comparison of the principal headings for this cause of death since the beginning of the century is:

Accidents and Negligence, Death Rates per Million

Period	(Ages under 1)					
	Males			Females		
	Burns and Scalds	Suffocation	Total	Burns and Scalds	Suffocation	Total
1901-10	148	1,827	2,340	144	1,782	2,253
1911-20	150	1,231	1,539	121	1,172	1,435
1921-30	147	658	886	116	592	772
1931-40	137	665	871	110	484	660
1941-47	88	985	1,184	72	753	913

Accidents and Negligence, Death Rates per Million
(Ages 1-5)

Period	Males					Females				
	Falls	Burns and Scalds	Drown-ing	Vehicles	Total	Falls	Burns and Scalds	Drown-ing	Vehicles	Total
1901-10	65	435	107	86	778	44	406	48	60	612
1911-20	49	374	109	103	705	29	348	39	64	536
1921-30	32	311	77	157	628	20	228	29	93	401
1931-40	32	204	68	177	526	22	154	25	103	333
1941-47	32	116	111	165	494	22	113	34	102	318

Apparently boys did not have the care and attention that their sisters had or they succumbed to injuries more easily. A difference in the male and female character, for example a greater desire for adventure or exploration in the boys, can hardly be an explanation of the whole of the male excess since, at any rate in the first year of life, the child contributes little to the train of events leading to the fatality.

Ages 5-9.—During 1841-85 the females had a slight advantage in mortality rates over the males, which they lost for 25 years during 1886-1910. For the past 40 years, however, the death rate for females has steadily shown a greater relative improvement than that for males. A comparison of the mortality ratio during these three periods for the years when the ratio was at a maximum or minimum is:

Diseases	1876-80		1901-05		1941-45	
	Mortality Sex Ratio	Deaths as Percentage of all Causes	Mortality Sex Ratio	Deaths as Percentage of all Causes	Mortality Sex Ratio	Deaths as Percentage of all Causes
Infectious diseases	99	49	87	34	101	23
Tuberculosis	108	15	95	18	105	12
Nervous system	116	9	100	8	114	6
Respiratory system	101	9	101	13	122	8
Digestive system	104	3	96	6	128	8
Violence*	219	6	147	7	228	26
Other causes	114	9	103	14	111	17
All causes*	108	100	97	100	131	100

* Excluding war casualties.

Changes in classification due, to a large extent, to improved diagnosis, may have a different effect upon individual causes of death; but it is not likely that any such changes that occur in the broad groups of causes of death will materially affect a comparison of the mortality ratios. In 1901-5 they were lower for each cause of death than in either of the other two periods. The largest changes in the relative importance of the causes of death between these periods were the decline in infectious diseases from one-half to one-quarter of all causes, and the rise in the proportion of violent deaths from one-seventeenth to one-quarter. The most dramatic decline in the group of infectious diseases was that of scarlet fever. In the peak year of 1870 this disease was responsible for the deaths of 8,540 children aged 5-9; in 1947 for only 8. The large decrease in the mortality ratio from violence in 1901-5 was caused by a decrease in the mortality of males, while that of females remained practically the same as in 1876-80. The rise in 1941-5 was due to a larger increase in the death rate for males. A comparison of the deaths by type of accident, for these three periods, is:

Death Rates per Million from Violence
(Ages 5-9)

Cause	1876-80		1901-5		1941-5	
	Males	Females	Males	Females	Males	Females
Vehicles	90	24	74	22	278	126
Drowning	199	29	117	12	118	19
Burns and scalds	80	130	56	154	23	51
Other violence	137	48	87	38	193	127
Total	507	232	334	227	612	323

1951]

Between 1876-80 and 1901-5 there was a substantial reduction in the death rate from violence, but in 1941-5 the rate had risen, due, mainly, to the large increase in road accidents. Throughout the period girls had a greater risk of dying from burns and scalds than boys.

Although most causes of death contributed to the male excess of mortality in 1941-5, deaths from violence were responsible for a large part of this excess. If the male death rate from violence had been the same as the female rate the ratio of male to female mortality from all causes would have been reduced from 131 to 113.

Ages 10-14.—During the first 85 years of the period the mortality ratio fluctuated round a fairly constant level; boys had a very slight advantage in mortality over girls during this period. For the last 20 years the position has been reversed, and girls now have the lower death rate. A comparison of the causes of death, before the rise in the mortality ratio commenced and at the end of the period, is:

Disease	1921-5		1941-5	
	Mortality Sex Ratio	Deaths as Percentage of all Causes	Mortality Sex Ratio	Deaths as Percentage of all Causes
Infectious	93	14	107	12
Tuberculosis	64	25	74	17
Rheumatism, Nutrition, etc.	77	7	83	5
Nervous system	109	10	122	7
Circulatory system	74	10	76	8
Respiratory system	109	8	111	7
Digestive system	121	9	137	8
Violence*	329	9	313	21
Other causes	128	9	116	15
All causes	98	100	123	100

* Excluding war casualties.

Seven of the nine groups had a greater mortality sex ratio in 1941-5 than twenty years earlier. The chief factors affecting the large increase in the mortality ratio from all causes were a large decline in the relative importance of tuberculosis, the cause of death with the lowest mortality sex ratio, and a large rise in the proportion of violent deaths, the cause with the highest sex ratio.

3.2. Young Adult Life

The absence of males in the services seriously affected the mortality sex ratio during the war years; for this reason comparisons in the following age groups have not been taken beyond 1939.

Ages 15-19.—For the first fifty years of the period the death rate for males was below that for females, but in the following years the position was reversed; by the end of the period males had an excess mortality of 15 per cent. The most important cause of death throughout the 100 years was tuberculosis, to which were attributed between one-third and one-half of the total deaths in this age group. The only other important cause of death throughout the period was violence. Typhus was responsible for a large number of deaths in the early years, but disappeared by the end of the period. The relative position of these causes of death was:

Disease	1861-5		1901-5		1936-9	
	Mortality Sex Ratio	Deaths as Percentage of all Causes	Mortality Sex Ratio	Deaths as Percentage of all Causes	Mortality Sex Ratio	Deaths as Percentage of all Causes
Tuberculosis	73	46	82	36	65	34
Typhus	87	13				
Violence	559	7	357	8	354	16
Other causes	84	34	108	56	121	50
All causes	93	100	106	100	114	100

The death rate from tuberculosis in females in the first of the three periods was considerably above that in the males. Although there was a large absolute and relative fall during the 75 years, the disparity between the sexes was greater in the last period than in the first. Deaths from violence have not only increased in relative importance between 1901-5 and 1936-9 but the actual death rates increased from 3.7 to 4.6 per 10,000 for males and from 1.0 to 1.3 for females. This cause contributed largely to the excess of male mortality from all causes; if the males had had a death rate from violence equal to that of the females the mortality ratio would have been reduced to 97 in 1901-5 and to 95 in 1936-9. The mortality ratio from other causes showed a progressive increase, by 37, during the 75 years.

Ages 20-24.—For this age group the mortality ratio was fairly constant for the first 50 years; it then increased suddenly and remained constant, with the exception of the war years, at the higher level. The rise in the mortality ratio in 1896-1900 was due to the more rapid fall of the death rate in females; the death rates per 100,000 in 1891-5 and 1896-1900 were 525 and 491 for males and 482 and 415 for females. The greater decline in females was due to a general improvement rather than to any specific disease. The most important fall among specific causes was that of the death rate of diseases of pregnancy, which declined from 62 to 47 per 100,000. The high level of the mortality ratio in recent years has been maintained by the decline in tuberculosis, with a low mortality sex ratio, and an increase in violence, with a high ratio. Violent deaths as a percentage of all causes have risen from 7 in 1891-5 to 16 in 1936-9. An increase in the death rate from violence between these periods also occurred; the rates at the beginning and end of the period were 666 and 751 per 100,000 for males and 115 and 151 for females. The mortality sex ratios, in 1936-9, were 80 for tuberculosis, 497 for violence and 100 for all other causes. These three groups formed 38, 17 and 44 per cent. respectively of the total deaths.

3.3. Adult Life

The mortality sex ratio, as shown in Table 3, increased for each age group throughout the century. It increased with increasing age from 25-29 to 55-64, and then declined; for the oldest group, 85+, the ratio showed the smallest change in any group. The causes of death are more numerous and numerically more important in adult than in early life. Changes due to revision of classification have, consequently, been greater; comparison of deaths by causes cannot, therefore, be made for a long series of years. The mortality sex ratios for the numerically most important causes of death for the last period are:

Mortality Sex Ratios, 1936-9

Cause	Ages					
	25-34	35-44	45-54	55-64	65-74	75+
Infectious diseases	133	147	178	164	124	117
Tuberculosis	114	181	303	322	235	151
Cancer and tumours	97	64	80	116	135	125
Rheumatism, nutrition, etc.	74	54	49	55	64	80
Diseases of nervous system	131	120	110	110	111	106
" circulatory system	88	105	156	160	136	119
" respiratory system	167	209	294	243	154	119
" digestive system	157	175	188	162	130	120
" genito-urinary system	98	89	118	171	244	340
Violence	435	330	283	272	169	102
Other causes	25	43	105	127	114	103

A comparison of these ratios with those in Table 3 shows that, in each age group, most causes of death have now a higher mortality ratio than the ratio from all causes at any time during the century. Exceptions were rheumatism, diseases of nutrition, etc., which had a very low ratio in each age group, cancer up to age 54, and diseases of the nervous system from age 45. There has been a general rather than a specific increase in the mortality sex ratio during the period. The trend of the mortality sex ratio during adult life varies with disease. For six causes, infectious diseases, tuberculosis, cancer, diseases of the circulatory, respiratory and digestive systems there was a definite maximum between ages 45-64. Mortality from diseases of the genito-urinary

1951]

system increased faster throughout adult life in males than in females. A decline in the mortality sex ratio was shown by diseases of the nervous system and by "violence". The very low ratio for "other causes" in the age groups 25-34 and 35-44 was due to deaths associated with pregnancy; they formed 81 per cent. and 64 per cent. respectively of the deaths in these age groups. The omission of these deaths would increase the mortality sex ratio from 25 and 43 to 134 and 111.

4. Social Class

An examination of the mortality sex ratio shows that the well-known upward gradient of mortality with social-class has a varying slope for males and females. The values of the mortality sex ratios for 1930-32 were:

Social Class	Ages				
	25-34	35-44	45-54	55-64	65-74
I	130	132	158	163	166
II	112	131	149	154	148
III	110	128	141	140	145
IV	114	139	146	139	141
V	101	132	153	139	147

The ratios do not follow the same order in each age group. In four age groups the ratio was highest for social class I and lowest for social class III. For classes I and II it progressively increased with age over the four age groups 25-64. In class III the ratio reached a constant level at age 45-54; in classes IV and V it had a maximum value in this age group. The size of the mortality sex ratio, for different individual causes of death, varies considerably, and while it is difficult to assess the relative importance of specific causes which contributed to the high ratios of classes I and II, that of heart disease is very large. Heart diseases were the largest cause of death; the deaths from these causes varied from one-fifth to one-third of all deaths in these age groups. The mortality sex ratios for tuberculosis and pneumonia were also very large.

5. Occupation

While the size of the occupational risk in males is probably important in determining the size of the mortality sex ratio, the actual assessment of its influence is difficult. In the decennial supplement for 1931 the Registrar-General tabulated the mortality of married women according to the occupations of their husbands. By using this tabulation an indirect estimate of the occupational risk may be made. For each occupation it is possible to calculate the ratio of the mortality of males (married and single) to the mortality of married women whose husbands followed the same occupation. The results within social classes may then be compared. Objections can be raised to a mortality sex ratio based on married and single men but, nevertheless, it gives an indication of the groups where occupational risk is excessive. For the larger occupational groups, where the deaths were not less than 20 in any age group, the mortality sex ratios are shown in Table 4. This table shows that the size of the mortality sex ratio varied considerably between and within the social groups. In only a few groups was the ratio consistently in excess or defect of the social class average throughout the period of working life. In social class I the outstanding departure from the average was the mortality sex ratio of physicians and surgeons, which was high up to age 65. In social class II the ratio for farmers was lowest in each age group, while that for "inn keepers, hotel keepers, etc." was the highest up to age 65. The occupations in social class III with low ratios were "gardeners, nurserymen, etc.", "railway engine drivers, etc.", railway signalmen, coal hewers and getters, and cotton textile spinners". The low value for the railway employees was probably due to selection; their occupations demand a certain standard of fitness. The low values for coal hewers and getters and for textile spinners were due to a high death rate in married women. The ratios were high for waiters and hairdressers; the very large values of the latter in the age groups 35-44 and 45-54 resulted from a very low death rate among the married women. Three of the occupations in social class IV had very high ratios from age 35-44, iron and steel foundry furnacemen and labourers, textile dyers, and makers of alcoholic drinks; a low ratio was recorded by other underground coal workers. The most notable departure from the average of class V was the low ratio for agricultural and gardeners' labourers.

Summary

During the past hundred years the death rate in females has declined relatively faster than in males, particularly during the latter part of the century. Every age group has shown this trend, although it has been less marked in the very young and very old age groups. An examination of the geographical distribution of mortality shows that, although regional variations exist, the relative excess of mortality in males has been a feature of the whole country. Changes in the relative importance of the various causes of death have affected the mortality sex ratio during the period. For example at ages 5-9 infectious diseases accounted for half the total deaths in 1876-80 but only a quarter in 1941-45, while the proportion due to violence rose from 6 per cent. in the first period to 26 per cent. in the latter. This large relative increase in violence was responsible for a large part of the male excess.

During adult life the mortality sex ratio varied considerably with age. At the end of the period studied the male death rate from violence was four times as great as the female rate at ages 25-35; the ratio gradually declined to approximate equality by old age. The mortality sex ratios of tuberculosis and of diseases of the respiratory system were at a maximum at ages 45-55, when the male death rate was three times the female. The mortality sex ratio of "rheumatism, nutrition, etc." had a minimum value at ages 45-55, when the male death rate was only half of that of the females.

It is difficult to assess the effects of social class or occupation on the mortality sex ratio. Social class I tended to have the highest ratio at ages 25-75, while class III had the lowest. The course of the ratio during life varied with social class. While in the highest classes the ratio tended to increase throughout life, in the lowest classes it reached a maximum at ages 45-54. During working life mortality sex ratios for different occupations did not, as a rule, vary in the same way with age. Although some occupations showed considerable departure from the mean, the evidence of an occupational risk is not very conclusive.

TABLE 1

Death Rates and Ratio of Male and Female Mortality. England and Wales

Period	Crude Death Rate per 1,000 Living		Ratio of Male to Female Mortality (adjusted for age differences)
	Males	Females	
1841-45	22.1	20.6	1.096
1846-50	24.1	22.6	1.088
1851-55	23.5	21.8	1.099
1856-60	22.6	21.0	1.095
1861-65	23.7	21.5	1.116
1866-70	23.7	21.2	1.132
1871-75	23.3	20.7	1.150
1876-80	22.1	19.5	1.160
1881-85	20.5	18.3	1.152
1886-90	20.0	17.8	1.164
1891-95	19.8	17.7	1.161
1896-00	18.8	16.6	1.178
1901-05	17.1	15.0	1.191
1906-10	15.6	13.8	1.198
1911-15	15.4	13.3	1.226
1916-20	16.5	12.8	1.282
1921-25	12.9	11.4	1.240
1926-30	12.9	11.4	1.268
1931-35	12.7	11.4	1.276
1936-40	13.5	11.6	1.337
1941-45	15.1	11.1	1.414
1946	13.4	10.9	1.378
1947	13.5	11.3	1.389

TABLE 2

The Standardized Death Rate for Males Expressed as a Percentage of the Female Standardized Death Rate

Period	London	South East	South Midlands	East	South West	West Midlands	North Midlands	North West	York- shire	Northern	Wales
1841-45	120	109	105	106	111	110	105	109	108	113	113
1846-50	117	106	105	105	111	110	104	109	107	111	115
1851-55	121	109	107	108	111	113	104	111	110	112	115
1856-60	121	109	107	107	111	112	105	111	110	111	116
1861-65	122	113	109	109	113	114	105	112	111	111	115
1866-70	123	115	112	109	115	114	106	114	112	110	117
1871-75	123	116	113	112	115	116	111	116	114	114	117
1876-80	124	118	113	113	114	117	110	116	116	113	116
1881-85	123	117	115	113	114	117	111	115	114	111	115
1886-90	122	117	115	112	115	117	112	115	116	112	115
1891-95	123	117	116	113	116	117	113	116	117	110	116
1896-00	127	120	117	116	117	120	113	117	118	113	114
1901-05	127	123	118	117	119	119	115	119	118	113	114
1906-10	126	121	117	114	116	118	114	118	118	115	114
1921-25	127	119	118	117	115	121	115	121	119	115	115
1926-30	128	120	117	118	117	120	116	121	119	116	117
1931-35	131	123	120	119	120	122	117	122	119	117	117
1936-40	133	126	122	122	122	123	119	123	122	119	120

TABLE 3

The Male Death Rate, in Age Groups, and Infant Mortality, Expressed as a Percentage of the Female Death Rate

Period	Ages												Infant Mortality
	0-4	5-9	10-14	15-19	20-24	25-34	35-44	45-54	55-64	65-74	75-84	85+	
1841-45	117	103	94	88	104	94	101	114	111	111	109	106	122
1846-50	116	103	94	91	104	94	99	113	112	111	109	107	121
1851-55	116	102	97	90	104	97	102	118	114	112	110	106	122
1856-60	115	99	96	91	102	96	103	118	115	111	108	107	121
1861-65	115	103	98	93	106	99	109	122	118	112	109	110	122
1866-70	115	107	101	93	107	105	113	124	120	115	109	111	120
1871-75	117	107	101	96	109	108	119	128	121	114	111	110	121
1876-80	118	108	98	96	108	108	119	129	122	114	112	111	122
1881-85	118	103	96	96	101	104	117	127	122	116	113	112	122
1886-90	119	100	94	99	106	107	117	129	122	117	112	114	121
1891-95	119	99	94	101	109	108	118	128	121	115	111	110	122
1896-00	118	99	97	107	118	115	122	129	124	117	113	109	121
1901-05	119	97	96	106	120	117	121	130	128	119	115	110	122
1906-10	119	97	94	108	119	118	122	129	128	121	115	113	123
1911-15	120	101	97	109	122	126	127	131	133	124	118	115	125
1916-20	121	100	94	107	148	147	142	135	137	132	121	111	128
1921-25	124	106	98	104	114	113	129	132	133	128	120	113	130
1926-30	125	110	105	107	112	111	132	137	136	131	123	117	131
1931-35	126	110	105	110	114	107	125	141	139	132	124	114	130
1936-40	128	115	112	115	120	115	129	147	152	136	130	113	129
1941-45	126	129	124	128	207	169	147	153	165	144	130	109	127

TABLE 4

*The Death Rates of Occupied Males Expressed as a Percentage of the
Death Rate for Married Women, 1930-32*

Occupational Group	Ages				
	25-34	35-44	45-54	55-64	65-74
<i>Social Class I:</i>					
Bank and insurance officers	117	103	142	133	161
Clergymen, Anglican	—	130	90	125	162
Clergymen, other religious bodies	—	104	134	157	170
Physicians and surgeons	167	158	198	185	168
Professional engineers	115	104	146	163	160
Total, Class I	128	130	152	163	163
<i>Social Class II:</i>					
Farmers	90	92	117	122	124
Retail proprietors—grocery, etc.	134	123	138	153	149
—dairy, meat, fish, etc.	112	149	163	155	157
"Commercial" travellers	122	130	144	164	169
Teachers (not music)	106	112	126	139	151
Inn keepers, hotel keepers, etc.	137	196	196	181	155
Total, Class II	119	134	154	161	155
<i>Social Class III:</i>					
Gardeners, nurserymen, seedsmen, florists	124	118	122	117	123
Coal hewers and getters	81	111	129	114	131
Furnacemen, rollers and their skilled assistants	87	113	129	169	129
Metal moulders and die casters	109	122	137	128	148
Textile spinners, cotton	84	109	114	129	135
Boot and shoe workers and factory operatives	133	170	131	122	150
Carpenters	99	116	138	137	148
Masons	95	163	172	161	154
French polishers	120	87	179	155	182
Paper hangers, painters, etc.	117	133	174	170	165
Railway engine drivers, etc.	84	119	102	133	138
Railway signalmen	99	79	125	141	129
Salesmen, dairy, meat, fish, greengrocery	140	176	134	152	144
Waiters	157	156	155	291	170
Hairdressers	133	229	205	170	162
Total, Class III	111	126	137	136	138
<i>Social Class IV:</i>					
Coal, other underground workers	121	118	117	121	143
Coal, workers above ground	118	136	134	127	136
Other skilled workers in gas service	—	92	157	119	200
Iron and steel foundry furnacemen and labourers	114	135	182	158	163
Textile dyers	110	156	186	150	144
Makers of alcoholic drinks	91	176	181	210	145
Road transport, horse drivers	104	140	162	141	155
Boiler firemen and stokers	86	110	122	124	130
Total, Class IV	114	131	151	138	143
<i>Social Class V:</i>					
Agricultural and gardeners' labourers	98	106	111	115	128
Builders', bricklayers', plasterers' labourers	80	106	142	141	146
Water transport, dock labourers	108	150	181	132	141
General labourers and other unskilled workers	102	128	150	135	145
Total, Class V	102	131	151	138	143

DISCUSSION ON DR. MARTIN'S PAPER

Mr. STARKE: I am very happy to propose a vote of thanks to the author for his paper on a subject which has not, I think, been discussed by the Society—at any rate in recent years. It seems fitting that it should be presented during the term of office of a President who is such an authority on the statistical treatment of both mortality and morbidity.

In this country we have reason to be proud of our mortality statistics. The national records provide a run of material which has continued unbroken for over a hundred years, and there must be many statistical workers in other fields who would give a great deal to have such an impressive array of time series at their disposal. Some may perhaps think it rather odd that within the field of vital statistics the most complete figures should be those which deal with the extinction of the vital spark.

Although mortality is one of the few characteristics which we all have in common, the statistical study of the subject is almost exclusively the concern of the medical statistician and the actuary.

The rate of mortality is the bone on which the budding actuary cuts his teeth. The paper to-night is concerned with sex differences in mortality; if this aspect of the subject has been somewhat neglected by the actuarial mind, it is because until comparatively recently women have not offered much of a market for life assurance.

No one who has read the paper can fail to realize the colossal amount of arithmetic which must have gone into the preparation of it; and I feel that the author has done a substantial service to statistics by undertaking this work and setting out the results with such simplicity and clarity. I congratulate him, too, on having resisted the temptation to foretell the course which mortality is likely to take in the future. In my own remarks I shall certainly follow his example; but I hope I shall not dissuade other speakers from having a crack at the subject.

I have been tempted to regard the paper as one on sex as much as one on mortality. From that point of view, I think it suggests a need for at least two further papers, the first to attempt to go rather more deeply into the question *why* the female of the species is hardier than the male, and the second to discuss the effects of this phenomenon on the sex constitution of the population.

The first of these problems is perhaps hardly one for the statistician at all. In a normal civilized non-totalitarian community one cannot make investigations about human mortality by conducting controlled experiments with random samples in a laboratory. But there may be with us this evening some biologist or other natural philosopher who can at least tell us whether there is any evidence of this sex difference in mortality in living organisms outside the human species. We all know about the lady spider who consumes her spouse as part of the normal marital routine, and we have no difficulty in classifying his fate as death by violence. But how little—or how much—do we know about the demography of the animal kingdom in general? I suspect that if we have any serious scientific information about this it is confined to mice, guinea-pigs and so on—which are convenient to accommodate within the average laboratory.

Returning to the paper, it is clear that, as the author indicates, some part at any rate of the difference between the mortality of the sexes can be ascribed to environmental influences—occupational hazards, social habits, and so on. The fundamental difficulty is that we have no adequate means of allowing for these different factors in the exposed to risk. To get away from this difficulty one is thrown back on a comparison of the male and female rates in infancy. One of the categories which affords a clear picture of the extent to which the sex difference in mortality is affected by differences in exposure to risk associated with age is “death by violence,” and within that category “death from road accidents” in particular. This matter was commented on by Sir George Maddex in the discussion on Dr. Smeed's paper to the Society on “Some Statistical Aspects of Road Safety Research”,* and it cannot fail to attract notice in any analysis of death-rates by sex, age and cause. One can understand the large differences in the rates at the adolescent and adult ages, or even at the school ages; but the excess of male mortality is considerable in infancy and at the pre-school ages, where environmental influences cannot differ greatly with sex, and as the author points out on page 292, attempts to explain the difference by way of the alleged greater adventurousness of the male are rather thin. I am at a loss to imagine how mysteries of this kind can be further elucidated by purely statistical methods; and, as I have already said, any contribution from a wider point of view which the paper may elicit cannot fail to be of interest.

The second topic which I mentioned was the effect of sex differences in mortality on the sex-constitution of the population. Here another phenomenon comes into the picture—the relative number of births of each sex or, as it is usually called, the masculinity ratio. It is a well-known fact that rather more boy babies are born than girl babies. The figures suggest that the ratio of boys to girls is greater during and immediately after a major war, and those who wish to do so are free to assume that this is due to some compensatory influence at work in nature. Here again we

* *J. R. Statist. Soc.*, 112, 1949.

cannot stage an experiment to find out what the truth really is ; but as regards the masculinity ratio in general we can at any rate say that the consistent excess in male births offsets a good deal of the effect of the lower female mortality. That there must be some offsetting effect is obvious without any arithmetic; a theoretical demonstration can be provided by constructing life-tables for each sex on the basis of the mortality current at any time, the radices of the tables being proportional to the contemporary numbers of male and female births. By comparing the two columns of the life-table populations one can ascertain the age at which the initial superiority in numbers of the male population would be cancelled by the higher mortality which it experiences as compared with the female population. I say "would be cancelled" because the one thing that is certain about a life-table is that the position it depicts will never be realized. The rates of mortality are subject to change; the ratio between the rates for males and females is subject to change; the masculinity ratio itself fluctuates appreciably from one period to another. Immigration, emigration, wars and other phenomena—none of which is allowed for in the life-table—may disturb the sex-constitution of the population. Another factor is the still-birth rate for each sex; it appears that male mortality is heavier than female mortality not only from birth onwards, but at or even before birth.

To any who may be unaware of what has already been written on the subject I would mention a short but extremely interesting note by W. S. Hocking in vol. 74 of the *Journal of the Institute of Actuaries*.

There are a number of points in Dr. Martin's paper which call for comment as matters of particular interest—among those which intrigued me was the use of social class figures to suggest a relationship between the male/female mortality ratio and the level of the infant mortality rate—but I must leave these to other speakers and conclude by again proposing a hearty vote of thanks to the author for his industrious and interesting paper.

Dr. J. O. IRWIN: I am much pleased to second this vote of thanks to Dr. Martin for his paper. The reason for my pleasure, however, is not that I am in any way an authority on the subject, but because Dr. Martin is a very old colleague and this is the first time I have had an opportunity of paying a tribute to him in public. He has completed many studies of this kind, which always show a careful attention to statistical accuracy and a detailed knowledge of the underlying material.

However, sometimes when one comes fresh to a subject or when one re-examines it, a new idea may present itself. I do not know for certain whether this is a new idea, but after first reading the paper, I found myself wondering why it is customary to use the ratio of male to female mortality rather than some other comparative measure. It occurred to me that if the regression of male on female mortality were linear, say

$$M = a + bF \quad \text{with } a, b \text{ positive and constant}$$

then

$$\frac{M}{F} = \frac{a}{F} + b$$

would increase as the level of mortality declined. Might not this be part of the explanation of the observed phenomenon?

It is well known that more males are born but more females survive. If this were entirely due to pre-natal causes, one might suppose that while a general improvement or deterioration in environment would alter the general level of mortality, the form of the regression would be maintained; and if one were looking for such a simple relation one would choose that age group in which differential effects of environment as time went on would be a minimum. (By differential effects I mean changes in environment which affect differently different portions of the age group, for example changes in the proportions of people in different occupations.) So if one were looking for the relation one would examine infant mortality first.

After we had talked the matter over, this is just what Dr. Martin did. He calculated the regressions in quinquennial periods from 1871–75 to 1941–45. When plotted out the results are striking. The fifteen regressions almost form one continuous line, and the time order is preserved. There are some irregularities between 1871 and 1895 and notably in 1891–85, and a tendency for the regression to steepen after 1930; but between 1895 and 1930 they form one continuous straight line. In this period the regression coefficients are all between 1.08 and 1.24, over the whole period they are between 0.99 and 1.51. All values over 1.25 are in the last three quinquennial periods when they are respectively 1.5, 1.4 and 1.3. The constant terms in the equations are more irregular but there is a compensating effect, the small constant terms

recurring with the larger regression coefficients. The constant terms become negative in the last three quinquennial periods when the ratio was declining.

The results in other age groups which Dr. Martin has also calculated are much less simple. The separate regression lines do not form one continuous line but change in position. One is tempted to conclude that this is due to differential environmental effects, but it may be premature to do so. He has also worked out the regressions of male on female infant mortality for different causes of death. For pneumonia all forms, for bronchitis and for diarrhoea and enteritis the slopes are in the same range as before, they are a little lower for tuberculosis and much lower for congenital malformations. The last result would not be unexpected if one regarded a fixed regression as a biological phenomenon due to genetic or prenatal causes.

Clearly the new results need further study and analysis, but are sufficient to justify a plea for regression analysis in the study of these and similar problems.

Dr. D. SWINSCOW said that Dr. Martin had emphasized how mortality sex ratios had changed in the course of years, but there was another feature of mortality sex ratios which was, he thought, of interest. Paradoxically it was their remarkable constancy from year to year. One reason why some of Dr. Martin's figures showed change rather than constancy was because many of his sex ratios were related to broad groups of disease, and he rightly concluded that changes in the relative importance of the various causes of death had affected the mortality sex ratio during the period reviewed. In other words, the sex ratio over a group of diseases had changed not because the sex ratios of deaths from the component diseases had changed but because some diseases had become relatively more important in the group as a cause of death.

When the sex ratios of deaths from a particular disease were considered over, say, a decade, they were found to be fairly constant from year to year and specific to that disease. It seemed possible that these ratios might be a useful test of homogeneity of the records of deaths from certain causes, i.e., a test of the accuracy of diagnosis of the cause of death.

Dr. Swinscow said that before giving some figures to show what he meant, he would make a plea that sex ratios based on actual numbers, not on rates as here, should be given in the form of male deaths expressed as percentage of total deaths, not in the traditional form that Dr. Martin had used—male deaths as a percentage of female deaths. The form in which Dr. Martin had given them was sometimes found in papers where actual numbers were used. The advantage of giving male deaths as percentage of total deaths was that tests of significance could readily be applied to the percentages.

The ratios he was about to give were expressed in that form because their significance had been tested by means of their standard errors. As regards the constancy of the ratio: in the decade 1929–38 male deaths from whooping cough were 44.1 per cent. of the total deaths from whooping cough, and in the decade 1939–48 the percentage was 43.9. Within each decade the percentage for each year was tested to see if it departed significantly from the percentage for the other nine years combined. A significant departure was admitted when the difference between the percentages exceeded twice the standard error of the difference. In the decade 1929–38 there was no significant departure in any year; in 1939–48 there was one year, 1940, which showed an unusually high percentage, 48.1. But that result did indicate useful constancy over two separate decades in regard to a group of deaths whose diagnosis was probably fairly consistent.

Dr. Swinscow then gave some figures of neonatal deaths in the decade 1939–48. The population at risk for neonatal death varied slightly from year to year in accordance with the sex ratio of live births, but the variation in that decade was too small to affect results materially. He imagined a rather heterogeneous collection of deaths was assigned to the cause "premature birth". In 1939–48 the percentage of male deaths from this cause was 57.05, and in four years out of the ten the percentage differed significantly from the percentage for the other nine years combined. That might well indicate the heterogeneity of the true causes of death under that heading.

For contrast we might take haemolytic disease of the new-born, which was a recognized entity long before the Rh factor was discovered. Male deaths from that cause in the decade constituted 62.36 per cent. of total deaths from that cause, and in no year did the percentage differ significantly from the percentage of the other nine years combined. That suggested that the material was fairly homogeneous. Under the heading "injury at birth" the Registrar-General had three sub-headings. The first was "intracranial or spinal haemorrhage due to injury at birth", which was a relatively well-defined category in comparison with the third, which was "other birth injuries", something relatively indefinite. Under the first category the percentages of male deaths were consistent and in no year departed significantly from the percentages for the other nine years, but in the category called "other birth injuries" there were two significant departures in the ten years, which was the kind of result one might expect.

Further investigation was needed to decide whether a test on these lines was feasible or of practical use, but it might be worth while.

Dr. LOGAN said that before discussing the mortality sex ratio he would say a word or two about the effect of changes in the classification of causes of death. Dr. Martin took an unnecessarily pessimistic view of the difficulties caused by these changes, though it might be that he had had some painful experiences owing to them. To suggest, however, as he did that there had recently been a complete break in continuity was perhaps being rather hard. Changes of classification had been made approximately every 10 years since 1901. On most occasions the changes were small, and, with a certain amount of book-keeping, allowances could usually be made for changes from one revision of the classification to another. The change that was made in 1940, however, was much greater than previous ones owing to the adoption of a new system for selecting the cause of death for assignment when more than one cause was mentioned on the death certificate. Previously the assigned cause had been selected by means of a system of arbitrary rules giving an order of precedence to the various causes mentioned; thus violence had a high priority, and so, too, had the infectious diseases. Since 1940 selection of the underlying cause has been based upon the certifying practitioner's opinion as indicated by the order in which he stated the several causes on the certificate. Before changing from the one system to the other the Registrar-General tabulated causes of death by both systems during the four years 1936-39. As a result of this dual tabulation conversion factors were calculated and published which permit comparison between the pre-1940 and post-1940 records. Thus, though there was a break in continuity in 1940 the break was not complete, and by means of the four-year bridge it was possible to cross from one side of 1940 to the other.

Dr. Martin had chosen congenital malformations as one of his five main groups of causes of infant mortality. It should be noted, however, that in regard to sex ratio congenital malformations formed a highly heterogeneous group in which certain conditions showed a pronounced excess of deaths of females, and others of males. Examples of the former, with female excess, were spina bifida, meningocele and monstrosities, and of the latter, with male excess, pyloric stenosis, hydrocephalus, congenital heart disease, cystic disease of the kidneys and imperforate anus.

Another grouping of conditions that were heterogeneous in regard to mortality sex ratio was that of measles, scarlet fever, diphtheria and whooping cough. The combined sex ratio of those common infections of childhood in 1940-47 was 90, indicating a female excess. This excess of death of girls was entirely due to whooping cough with a sex ratio of 74. In showing such an excess of female deaths whooping cough was quite exceptional, and the mortality sex ratios of the other diseases were scarlet fever 114, diphtheria 109, and measles 107.

Dr. Martin had drawn attention to the excess of male deaths in childhood resulting from accidents; but in attributing this excess to the male desire for adventure, he was at a loss to account for the presence of this male excess even during infancy. It would be noted, however, that much of the male excess of accidental deaths during infancy derived from deaths from suffocation. In recent years serious doubts had arisen in certain quarters about whether many of these children did in fact die from suffocation and claims had been made that careful autopsy of such cases would reveal evidence of a fulminating infection, often pneumonia. If this were so then the excess of deaths from "suffocation" among male infants was related to the male excess of deaths from infections in general.

At ages 1-5 there was a large male excess of deaths by drowning and the deaths of boys by drowning almost doubled during 1940-47 compared with 1931-40. Many of these deaths were due to children drowning themselves in wartime static water tanks. Between 1941 and 1945 130 children aged between 1 and 15 were drowned in this way, and of these 121 were boys and only 9 were girls—a clear illustration of the male desire for adventure.

Mr. R. D. CLARKE said that in his extremely informative paper, Dr. Martin had given three interesting facts about the mortality sex differential. Firstly, it had been steadily increasing during the past century. Secondly, it tended up to a point to increase with age—although it diminished again at the most advanced ages. Thirdly it was greatest in social class I.

These conclusions provided valuable corroborative evidence to some results emerging from the mortality experience of annuitants which were recently published in the *Journal of the Institute of Actuaries*.* Annuitants were, for the most part, elderly persons drawn from the upper social classes. When the mortality experienced during the period 1926-1948 was examined it was found that female mortality had declined over this period to a much greater extent than male mortality. Indeed, at ages over 75 the male mortality had hardly declined at all.

* J.I.A., 76, 130 (1950).

This result was rather puzzling at the time and seemed to suggest either that the distribution by social class of male annuitants had changed in a way which had not applied in the case of female annuitants or that the improvement in mortality among annuitants had been different from that of the population as a whole. Dr. Martin's analysis of population mortality by social class, although it did not exclude the first hypothesis, provided important evidence for the second hypothesis. In other words, men of the upper social classes had not participated in the general improvement in mortality to the same degree as other sections of the population.

It might perhaps be of interest to record that the mortality sex ratio of 166 given in the table (on p. 295) for social class I, ages 65-74, over the period 1930-32 compared with 170 for annuitants in the same age group over the period 1931-35. It was always rather satisfying to get so close an agreement from two entirely unconnected sources.

It was irresistible to speculate on the question why the mortality sex differential in what we might describe as "elderly middle age"—namely, 55 to 74—should be so high in social class I. It would appear from a statement (on p. 295) that Dr. Martin had actually carried out an analysis by age and cause of death within social classes similar to the table appearing on p. 294. If so it would have been valuable if the analysis could have been reproduced in the text. Had this been done one would have expected to find that an appreciable part of the male excess in social class I was attributable to deaths from coronary thrombosis. Everyone was aware that coronary thrombosis was virtually an occupational disease among men of the professional and administrative class. In 1948, diseases of the coronary arteries accounted for 13 per cent. of the deaths among the male population of England and Wales over the age group 55 to 74. The corresponding mortality sex ratio was 247. Similar data for the social classes were not available from published sources, but it was only too likely that in social class I both the percentage and the sex ratio would have been higher.

As recently as January, 1950, a paper was published in the *British Heart Journal* by Ryle and Roberts which suggested that not only had the incidence of coronary disease been steadily increasing for many years, but that the increase was likely to continue with small hope of relief. It was therefore worth noting that *The Lancet* of March 24th, 1951, contains a leading article on the use of anti-coagulants in the treatment of cardiac infarction which reviewed results obtained in recent years in Denmark, in America, and in this country. Although it was apparently too early to form a quantitative estimate of the success which this form of treatment was likely to achieve, it at least seemed that some alleviation in the death rate from coronary thrombosis might now be in sight. As a result, some narrowing of the mortality sex differential for social class I might be regarded as possible in the not too distant future.

It seemed that the mortality sex differential was made up of a fundamental biological difference overlaid by an occupational difference. Even if men and women were naturally of equal longevity, there would still be an excess male mortality so long as society continued to need such people as coal miners and test pilots. But whereas the special risks inherent in many occupations were being reduced by improved conditions of work, there was at present very little being done to alleviate the occupational risks of the professional and administrative class—risks which might be summed up as the price of responsibility. He (the speaker) had just referred to the possible outcome of using anti-coagulants in the treatment of coronary thrombosis. But while this kind of medical discovery might play its part in reducing the excess mortality, what was even more necessary was the prevention of diseases like coronary thrombosis by relieving the nervous strain which would appear to cause them. Ultimately, he believed, that any substantial or permanent reduction in this high ratio of male to female mortality in the professional and administrative class must come from the psychiatrist and the neurologist.

Mr. F. J. LLOYD said that he had always known that women enjoyed a lighter mortality, but Dr. Martin's paper had brought home to him that this superiority of women existed at all ages, and that the gap between the sexes was still widening.

He thought it fair to say that the paper posed a question but did not answer it. He would add a small extra piece of evidence which he was afraid only heightened the mystery.

Recently he had been examining the sickness absence of men and women in industry doing the same jobs. By sickness absence he meant that absence from work which was ascribed to sickness. It was unnecessary to describe the methods of analysis used because the different experiences of the sexes was so distinct. These differences were not what one might have expected viewed against the background of mortality. The relationship between the sexes in terms of sickness absence was quite different. If one considered ages up to 50, then the single women suffered very much heavier sickness absence rates than men, and married women suffered even heavier rates than single women.

No doubt social, economic and administrative factors were all of more importance than the purely medical, but one would have expected, at first sight, a positive correlation rather than a negative one between sickness absence and mortality.

Mr. P. R. Cox said it would be interesting to extend Dr. Martin's survey to cover the relative sizes of the mortality rates of men and women in other countries throughout the world. Some idea of the results to be obtained might be derived from a glance at the Demographic Year Book of the United Nations. This showed that at the present time the superior vitality of the female was almost universal. It was least marked at ages 1 to 4, where male mortality was actually lighter in some countries, e.g., Palestine, Mexico and the Central and South American Republics. Occasionally one found a lighter male mortality rate at the child-bearing ages (for instance in Chile, Colombia and Burma) and in older childhood (in Chile and Japan). In Ceylon, female mortality was shown as being heavier than male mortality at all ages up to 40.

Data from the distant past were scanty, but Dr. Sigismund Peller had given some figures for the ruling families in Europe between the fifteenth and eighteenth centuries which demonstrated consistently lighter female death rates, and a similar feature was found in Swedish national statistics dating from 1750.

It seemed unlikely that there had always been a divergent trend between the mortality of the sexes, and indeed Peller's figures for the ruling families indicated a difference diminishing with the passage of time, although these were probably based on small numbers and might not be significant. However, England and Wales was not the only country to have a divergence at the present time; similar trends were observable in, for instance, Scotland and New Zealand.

According to the 1948 Annual Statistical Review of the Registrar-General for England and Wales, the difference between male and female mortality had increased in comparison with past years at ages 0-9 and at 45-64, but in other age groups the trend was less clear. At 20-34, indeed, the ratio of female to male mortality was higher in 1948 than it was before the First World War and at ages 20-24 it actually exceeded 100 per cent. in spite of the exclusion from the male population of the Armed Forces, which contain some of the healthiest men.

Nevertheless, the general trend in this country over the last half century had been for the ratio of female to male mortality to fall. This was evidenced by the results of the projections of mortality rates that were made for the Royal Commission on Population. All the various methods that were tried gave lower ratios for 1978 than for 1948, whether the secular trend or the experience of generations was taken into account.

It seemed that, strictly, on the theory of parallelism between the mortality curves of generations the ratio of female to male death rates should not vary from one generation to another, or at least should vary in a manner uniform for all ages. A comparison of the generations born in the years around 1833, 1843, 1853 and 1863 showed, however, that whereas the ratio varied little at ages 25-54 it declined steadily at ages 55-84.

The relatively scant attention given in the paper to maternal mortality seemed strange in a dissertation on sex differences, but puerperal causes accounted for only about 2 per cent. of female mortality over-all in the middle of the nineteenth century, and this proportion had fallen considerably since then.

The remark on p. 291 drawing attention to the apparent association between the sex ratios of infantile mortality rates and their absolute sizes was interesting. In the paper by Mr. Hocking, to which reference had already been made, it was shown that the ratio of male to female still-births fell from 1.234 in 1928-30 to 1.166 in 1943-45, while the proportion of still-births to all births fell from 4.0 per cent. to 2.8 per cent. The saving of male lives thus effected during this period might have had some effect on the infantile mortality rates and on their sex ratio.

The PRESIDENT recalled, with reference to Mr. Starke's question about relative sex mortality rates in animals, some figures he had given in the discussion on a previous paper read before the Society ("A Statistical and Economic Survey of Certain Aspects of the Beef Producing, Milk Producing and Cattle Rearing Industries in Great Britain between 1939 and 1945", by Miss Joan Marley, *Journ. Roy. Stat. Soc.*, 1947, 3, 187). Data collected and analyzed by Dr. R. Lovell and himself showed in calves a male mortality rate in the first week of life which was 26 per cent. above the female rate. Later mortality was seriously affected by the environment—whether the animal was destined to produce beef or milk. He also referred to Mr. Clarke's remarks on coronary thrombosis and the possible association of this cause of death with the alleged increasing strain of modern life. The issue of the *Lancet* from which Mr. Clarke had quoted also contained a letter suggesting as an alternative explanation the relative lack of physical and manual exercises as one went up the social scale. Possibly that explanation might fit the facts equally well.

1951]

The following written contribution was received after the meeting:

Mr. P. H. LESLIE: The excess mortality of males over that of females appears also in other species. The evidence for this is based on life tables for various species of animals observed in the laboratory. For small mammals, however, it is rare to find tables which are based on a sufficient number of life histories to distinguish any fine differences between the sexes. Wiesner and Sheard (1935) have published complete life tables for the albino rat (Wistar strain) housed in Edinburgh. The duration of life of individuals alive at the age of 31 days was 669.4 ± 3.57 days for 1,005 males and 693.1 ± 7.33 days for 843 females, the male q_x figures, except possibly in the very early stages of adult life, being consistently greater than those for females. According to these authors, the infant mortality was complicated by the fact that in a number of cases cannibalism occurred, leading to the death of every member of a litter. But, taking only those litters in which one or more young survived the age of 30 days, the infant mortality between birth and this age was $q_0 = 0.06457$ for 604 male live young and $q_0 = 0.05489$ for 583 female young. There was also a slight excess of male births. The general picture is thus very similar to that met with in man. That this phenomenon does not necessarily occur in all cases, however, is shown by some figures for a domesticated strain of the wild brown rat which was kept for many generations at the Wistar Institute, Philadelphia (King, 1939). Although complete life tables are not given for this stock, it is evident from the published figures that there was little difference between the sexes from weaning until the age of 20 months; in fact the males survived to this age, if anything, slightly better than the females. It is also interesting to note that in this stock more females on the average were born than males.

In the case of many insect species, the numerous life tables published by Pearl and his co-workers show a very definite tendency for the male mortality to be greater than the female. Owing to the difficulties of sexing the larvae and pupae, the origin of these tables for the separate sexes has to be taken at the emergence of the imago, and thus they refer only to the adult stages of life. For instance, Pearl and Parker (1924) give tables for two strains of *Drosophila melanogaster*, in both of which females had a longer duration of life than males. This difference also persisted under conditions of complete starvation. The same difference between the sexes was also noted by Pearl and Miner (1936) in the case of a moth, the pecan nut case bearer, *Acrobasis caryae*, and by Pearl, Park and Miner (1941) in the flour beetle, *Tribolium confusum*. In the latter the duration of life of the adult beetles was 177.8 ± 2.83 days for males, 198.5 ± 3.48 days for females. (It is to be noted, for the purpose of making any statistical comparisons, that Pearl gives \pm P.E.) In this same paper Pearl, Park and Miner also quote figures for various other beetles, showing that in 16 species out of 19 the duration of adult male life was shorter than that of females.

It therefore appears from the available evidence that the phenomenon of excess male mortality is not confined to man alone, but that it also occurs, though not universally, among a number of diverse and unrelated species.

References

- KING, H. D. (1939), *Amer. Anat. Mem.*, No. 17, 1.
PEARL, R., PARK, T., and MINER, J. R. (1941), *Amer. Nat.*, 75, 5.
— and PARKER, S. L. (1924), *ibid.*, 58, 71; 58, 193.
— and MINER, J. R. (1936), *Mém. Mus. Hist. Nat. Belg.*, 2^{me} sér., No. 3, 169.
WIESNER, B. P., and SHEARD, N. M. (1935), *Proc. Roy. Soc. Edin.*, 55, 1.

Dr. W. J. MARTIN replied in writing as follows:

Mr. Starke points out that the sex ratio at birth is greatest during and immediately after a great war. This is not, I think, due to any natural compensatory influence, but the ratio of male to female births is correlated with the age of the mother: a young woman has a greater chance than an older one of producing a male birth. During major wars the average age of women at marriage falls, with a consequent rise in the sex ratio at birth.

I agree that for many purposes the index advocated by Dr. Swinscow, the ratio of male to female deaths, has many points in its favour, but it does not necessarily give a picture of the difference in the actual rate of dying between the sexes. A straight comparison of deaths which ignores the exposed to risk of dying gives a somewhat different picture than that given by a comparison of the death rates, e.g., the proportion of male deaths in 1948 was 52 per cent. of all deaths, but the ratio of the adjusted male to female death-rate was 141 per cent.

While I may have been unduly pessimistic about the possibility of following causes of death through the changes in classification that have been made from time to time I think that Dr. Logan has tended to err in the other direction, especially in the first fifty years of registration. The ease with which the trend of mortality for a group of causes can be found depends on the

number of new titles and sub-titles that have been added or subtracted from the original group of causes; some of the necessary corrections are simple and some are not. Dr. Logan has just recently surveyed the changing causes of death during the past hundred years, and made, for a large number of causes of death, the corrections which are needed to link up the breaks in classification (*Population Studies*, Vol. IV, 2, 132-78).

Deaths from coronary diseases form an appreciable part of the male excess in social classes I and II as Mr. Clarke suggested. In 1931 the eight occupations with the largest standardized mortality ratio for this condition all belonged to these classes.

The difference in the sickness experience of men and women and the equally large difference between the experience of married and single women was, I think, first brought to general notice by the old National Health Insurance scheme. Many explanations have been advanced for part or the whole of the female excess, viz., economic, social, household duties, etc. It may also be that women tend to take greater care of themselves than men do, and from this aspect the findings of Cheeseman (Spec. Rep. Ser. Med. Res. Coun. No. 271) are interesting. The attack rate for all nasopharyngeal infections (less influenza) was over twice as high in girls' as in boys' schools. The correlations between nasopharyngeal infections and otitis media and nasopharyngeal infections and sinusitis were 0.696 and 0.711 for boys and -0.443 and -0.338 for girls. These values suggest that the greater attention given to minor ailments in girls' schools is reflected in a reduction of the incidence rates of the more serious complications. If this approximates to the real explanation and to the position throughout life, then a part of the relative high morbidity and low mortality of females could be explained by the same reasoning, viz., women take more care of themselves than men do, and thus complications and death following an illness occur less frequently among women than among men.

As a result of the ballot taken during the meeting, the candidates named below were elected Fellows of the Society:

John Archer.
Henry Arthur Rodney Barnett.
Lyle David Calvin.
Edith Winifred Cleaver.
Raymond Arthur Davies.
Andrew Hilary Elliott.
Ronald John Finlayson.
Llewelyn Frederick Gunaratna.
Gordon Albert Hosking.
Leonard George Huggett.
Philip Gaved James.

Matthew Henry Johnson.
Alec Miller Lee.
Bento José Murteira.
Peter Gath Lindsay Parkinson.
Arthur Charles Robb.
Douglas Stuart Robertson.
Stewart Edward Robertson.
Claud Richard Ross.
Ernest Rudd.
Lalgudy S. Vaidyanathan.

1951]

THE INFLUENCE OF PRICE IN INTERNATIONAL TRADE: A STUDY IN METHOD

By D. J. MORGAN and W. J. CORLETT

[Read before the ROYAL STATISTICAL SOCIETY, April 25th, 1951, the President,
Professor A. BRADFORD HILL, D.Sc., Ph.D., in the Chair]

CONTENTS

	PAGE
1. Introduction	307
2. Economic Assumptions of Simple Regression	308
3. Calculations Using Simple Regression	313
4. Introduction of Other Variables	316
5. Autocorrelation of Error Terms	318
6. Simultaneous Equations Approach	319
7. Construction of Models for Simultaneous Equations Approach	321
8. Model I: Wheat (Australia-New Zealand and Argentina)	323
9. Model II: Wheat (Australia-New Zealand and The Rest of the World)	328
10. Model III: Steel-Plates into Sweden	330
11. Model IV: Butter into the United Kingdom	333
12. Concluding Remarks on the Models	339
13. General Conclusions	341
14. Acknowledgments	347
15. References	347
16. Appendices:	
(1) Data for Regression Analysis	347
(2) Data for the Models	348
(3) Simple Regression of Data for Models	352

1. Introduction

It is of the greatest importance in applied international economics to collect all possible quantitative information throwing light on the probable magnitude of the elasticity of demand for the exports of various countries with respect to their prices. On the size of this elasticity depends the choice of instruments for restoring equilibrium to balances of payments. During the war and early post-war years a substantial number of statistical studies appeared which, without exception, suggested quite low values for these elasticities. In view of the significance attached in post-war arrangements to variations in exchange rates for coping with "fundamental" disequilibria in balances of payments, this general conclusion was highly disturbing. It was clearly pointless to examine the relative merits of exchange depreciation and quantitative import controls if the relevant elasticities were generally too small to permit adjustment by means of depreciation. It was natural to inquire with some care into the nature of the results which had such an important practical implication.

After studying the literature, in particular the work of Tinbergen (1946) and Chang (1948), it was felt that a more extensive inquiry should be put in hand to see whether the suggestion arising from relatively small samples was sustained. With that intention this project was started. The application chosen was that of imports of a commodity from two sources. We had not proceeded very far in applying the method of measurement used by Tinbergen, Chang, and others before we began to be concerned about the frequency with which we obtained measurements having the wrong sign. This made us wonder whether the method we were employing was entirely adequate for the task, and we began to try out alternative methods on the same collection of data. The results of this comparative study did not suggest we had found a satisfactory method for use in our proposed extensive inquiry. Instead we were led to turn our attention to the methods themselves. The project became a Study in Method. In this paper we outline the various stages in our inquiry, and explain why we consider that our quest for a satisfactory measure of elasticity of demand, or of some genuine substitute for it suitable in the field of international trade, has failed to reveal any method on the basis of which we feel justified in deciding between the alternative instruments available for correcting balance-of-payments disequilibria.

number of new titles and sub-titles that have been added or subtracted from the original group of causes; some of the necessary corrections are simple and some are not. Dr. Logan has just recently surveyed the changing causes of death during the past hundred years, and made, for a large number of causes of death, the corrections which are needed to link up the breaks in classification (*Population Studies*, Vol. IV, 2, 132-78).

Deaths from coronary diseases form an appreciable part of the male excess in social classes I and II as Mr. Clarke suggested. In 1931 the eight occupations with the largest standardized mortality ratio for this condition all belonged to these classes.

The difference in the sickness experience of men and women and the equally large difference between the experience of married and single women was, I think, first brought to general notice by the old National Health Insurance scheme. Many explanations have been advanced for part or the whole of the female excess, viz., economic, social, household duties, etc. It may also be that women tend to take greater care of themselves than men do, and from this aspect the findings of Cheeseman (*Spec. Rep. Ser. Med. Res. Coun. No. 271*) are interesting. The attack rate for all nasopharyngeal infections (less influenza) was over twice as high in girls' as in boys' schools. The correlations between nasopharyngeal infections and otitis media and nasopharyngeal infections and sinusitis were 0.696 and 0.711 for boys and — 0.443 and — 0.338 for girls. These values suggest that the greater attention given to minor ailments in girls' schools is reflected in a reduction of the incidence rates of the more serious complications. If this approximates to the real explanation and to the position throughout life, then a part of the relative high morbidity and low mortality of females could be explained by the same reasoning, viz., women take more care of themselves than men do, and thus complications and death following an illness occur less frequently among women than among men.

As a result of the ballot taken during the meeting, the candidates named below were elected Fellows of the Society:

John Archer.
Henry Arthur Rodney Barnett.
Lyle David Calvin.
Edith Winifred Cleaver.
Raymond Arthur Davies.
Andrew Hilary Elliott.
Ronald John Finlayson.
Llewelyn Frederick Gunaratna.
Gordon Albert Hosking.
Leonard George Huggett.
Philip Gaved James.

Matthew Henry Johnson.
Alec Miller Lee.
Bento José Murteira.
Peter Gath Lindsay Parkinson.
Arthur Charles Robb.
Douglas Stuart Robertson.
Stewart Edward Robertson.
Claud Richard Ross.
Ernest Rudd.
Lalgudy S. Vaidyanathan.

1951]

THE INFLUENCE OF PRICE IN INTERNATIONAL TRADE: A STUDY IN METHOD

By D. J. MORGAN and W. J. CORLETT

[Read before the ROYAL STATISTICAL SOCIETY, April 25th, 1951, the President,
Professor A. BRADFORD HILL, D.Sc., Ph.D., in the Chair]

CONTENTS

	PAGE
1. Introduction	307
2. Economic Assumptions of Simple Regression	308
3. Calculations Using Simple Regression	313
4. Introduction of Other Variables	316
5. Autocorrelation of Error Terms	318
6. Simultaneous Equations Approach	319
7. Construction of Models for Simultaneous Equations Approach	321
8. Model I: Wheat (Australia-New Zealand and Argentina)	323
9. Model II: Wheat (Australia-New Zealand and The Rest of the World)	328
10. Model III: Steel-Plates into Sweden	330
11. Model IV: Butter into the United Kingdom	333
12. Concluding Remarks on the Models	339
13. General Conclusions	341
14. Acknowledgments	347
15. References	347
16. Appendices:	
(1) Data for Regression Analysis	347
(2) Data for the Models	348
(3) Simple Regression of Data for Models	352

1. Introduction

It is of the greatest importance in applied international economics to collect all possible quantitative information throwing light on the probable magnitude of the elasticity of demand for the exports of various countries with respect to their prices. On the size of this elasticity depends the choice of instruments for restoring equilibrium to balances of payments. During the war and early post-war years a substantial number of statistical studies appeared which, without exception, suggested quite low values for these elasticities. In view of the significance attached in post-war arrangements to variations in exchange rates for coping with "fundamental" disequilibria in balances of payments, this general conclusion was highly disturbing. It was clearly pointless to examine the relative merits of exchange depreciation and quantitative import controls if the relevant elasticities were generally too small to permit adjustment by means of depreciation. It was natural to inquire with some care into the nature of the results which had such an important practical implication.

After studying the literature, in particular the work of Tinbergen (1946) and Chang (1948), it was felt that a more extensive inquiry should be put in hand to see whether the suggestion arising from relatively small samples was sustained. With that intention this project was started. The application chosen was that of imports of a commodity from two sources. We had not proceeded very far in applying the method of measurement used by Tinbergen, Chang, and others before we began to be concerned about the frequency with which we obtained measurements having the wrong sign. This made us wonder whether the method we were employing was entirely adequate for the task, and we began to try out alternative methods on the same collection of data. The results of this comparative study did not suggest we had found a satisfactory method for use in our proposed extensive inquiry. Instead we were led to turn our attention to the methods themselves. The project became a Study in Method. In this paper we outline the various stages in our inquiry, and explain why we consider that our quest for a satisfactory measure of elasticity of demand, or of some genuine substitute for it suitable in the field of international trade, has failed to reveal any method on the basis of which we feel justified in deciding between the alternative instruments available for correcting balance-of-payments disequilibria.

2. *Economic Assumptions of Simple Regression*

One of the methods which has commonly been employed for estimating the influence of price in international trade is the use of ordinary regression analysis to measure the elasticity of substitution between the imports into a country from two different sources. The imports considered may be those of a single commodity, as defined by trade statistics, or may be a group of commodities. The analysis is usually introduced by some such argument as the following:

Let the quantities imported from the two sources be x_1 and x_2 and let the corresponding prices be p_1 and p_2 .

If $\frac{x_1}{x_2} = f\left(\frac{p_1}{p_2}\right)$, the elasticity of substitution is measured by $\frac{d\left(\frac{x_1}{x_2}\right)}{d\left(\frac{p_1}{p_2}\right)} \cdot \frac{\frac{p_1}{p_2}}{\frac{x_1}{x_2}}$.

If, in addition, we assume that the form of the functional relation between relative quantities and relative prices is

$$\frac{x_1}{x_2} = A \left(\frac{p_1}{p_2}\right)^\beta,$$

then β will be the elasticity of substitution. By using data giving the quantities and prices for different periods and fitting a linear regression between $\log \frac{x_1}{x_2}$ and $\log \frac{p_1}{p_2}$,

$$\log \frac{x_1}{x_2} = a + b \log \frac{p_1}{p_2},$$

we shall get an estimate b of the required elasticity.

We must examine the assumptions made in this argument in order to see whether they are justified, and, if not, whether departures from the assumptions are sufficiently important in their effect to invalidate the method.

The first assumption we consider is the economic one implicit in taking relative quantities as a function of relative prices. The theory underlying this assumption is that of the simplest type of indifference curve between two commodities. The quantities of the two commodities bought then depends on their relative prices and the income to be spent on them, measured in terms of the quantity of one of the commodities which could be bought. As income changes, relative prices remaining unchanged, the quantities bought of the two commodities will alter. In the normal case the quantities of each commodity will increase as income increases. Obviously the simplest assumption to make is that the quantities increase in the same proportion. In this way we arrive at the assumption that relative quantities depend only on relative prices.*

In considering the implications of this assumption we shall retain the assumptions—

- (a) that we can consider the choices made by a country in obtaining imports as determined by indifference surfaces,
- (b) that these surfaces do not change over the time covered by our data, and—
- (c) that the quantities bought are those corresponding to the correct equilibrium positions on the indifference surfaces at the ruling prices and incomes.

We shall take first the case where there are only two commodities and consider just two observations. In the first position the quantities bought are x_1 and x_2 and the prices p_1 and p_2 ; in the second position there have been small changes in income and relative prices, so that the quantities bought are $x_1 + dx_1$ and $x_2 + dx_2$.

Let $x_1 + Rx_2 = \text{constant}$ be the equation of the tangent to the indifference curve at any point, so that, at a point of equilibrium $R = \frac{p_2}{p_1}$.

* Users of the method have, of course, realized that this assumption is only a special case, e.g., Tinbergen (1946).

1951]

The measure taken for the elasticity of substitution on the assumption mentioned is

$$\begin{aligned}\sigma_c &= \frac{d\left(\frac{x_1}{x_2}\right) \frac{p_1}{p_2}}{d\left(\frac{p_1}{p_2}\right) \frac{x_1}{x_2}} = \frac{d\left(\frac{x_1}{x_2}\right) \frac{1}{R}}{d\left(\frac{1}{R}\right) \frac{x_1}{x_2}} \\ &= \frac{R}{x_1 x_2} \frac{r x_2 + x_1}{\frac{\partial R}{\partial x_2} - r \frac{\partial R}{\partial x_1}}\end{aligned}$$

where

$$r = -\frac{dx_1}{dx_2}.$$

For the elasticity of substitution as theoretically defined the variation should be along the indifference curve with r taking the particular value R (cf. Allen, 1934).*

Hence, if σ is the theoretical elasticity,

$$\sigma_c = \sigma \frac{r x_2 + x_1}{R x_2 + x_1} \frac{\frac{\partial R}{\partial x_2} - R \frac{\partial R}{\partial x_1}}{\frac{\partial R}{\partial x_2} - r \frac{\partial R}{\partial x_1}}$$

Using the relations (e.g., Allen, 1934, pp. 200-1)

$$\begin{aligned}p_1 x_1 + p_2 x_2 &= \mu \\ p_1 x_1 \eta_1 + p_2 x_2 \eta_2 &= \mu \\ x_1 \eta_1 \frac{\partial R}{\partial x_1} + x_2 \eta_2 \frac{\partial R}{\partial x_2} &= 0 \\ R &= \frac{p_2}{p_1},\end{aligned}$$

where μ is the income, and η_1 and η_2 are the income elasticities of demand for the two commodities

$$\eta_1 = \frac{\mu}{x_1} \frac{\partial x_1}{\partial \mu} ; \quad \eta_2 = \frac{\mu}{x_2} \frac{\partial x_2}{\partial \mu},$$

we get

$$\sigma_c = \sigma \frac{r x_2 + x_1}{r x_2 \eta_2 + x_1 \eta_1}.$$

The estimate thus gives the true elasticity of substitution only if the last factor $\frac{r x_2 + x_1}{r x_2 \eta_2 + x_1 \eta_1} = 1$.

In the particular case where $\eta_1 = \eta_2 = 1$, this condition is satisfied for all values of r . This is, of course, simply the condition

$$\frac{x_1}{x_2} = f\left(\frac{p_1}{p_2}\right)$$

that a change in income, with prices unchanged, increases the quantities of the two goods bought in the same proportion.

If $\eta_1 \neq \eta_2$ the factor is not equal to 1 except when $r = R$. For other value of r it can take any value between $-\infty$ and $+\infty$. In particular, if r lies between $-\frac{x_1}{x_2}$ and $-\frac{\eta_1 x_1}{\eta_2 x_2}$, the calculated "elasticity of substitution" will be positive.†

* The definition given here differs in sign from that given by Allen. On our definition σ must be negative.

† This can be seen directly from a consideration of the indifference curves. The path of the actual change for this range of r lies between the income-consumption curve and the straight line through the origin giving equal proportionate changes of quantities. Relative quantities and relative prices will then move in the same direction.

This means that if income and the ratio of the price of the commodity with the greater income elasticity to the price of the other commodity move in opposite directions, the calculated value will be negative; if they move in the same direction, the value will be positive for "small" relative price changes and negative for "large" relative price changes. Thus, in this simple case, we might expect the calculated "elasticity" to have the "right" sign rather more frequently than it has the "wrong" sign, but the numerical value need not be near that of the true elasticity of substitution.

We may try to get a little further by expressing the factor $\frac{rx_2 + x_1}{rx_2\eta_2 + x_1\eta_1}$ in terms of the change in income and in the two prices. For small changes in income and prices $d\mu$, dp_1 and dp_2

$$r = -\frac{x_1}{x_2} \frac{A\eta_1 - Bx_2p_2\sigma}{A\eta_2 + Bx_1p_1\sigma},$$

where

$$A = d\mu - x_1dp_1 - x_2dp_2$$

$$B = \frac{dp_2}{p_2} - \frac{dp_1}{p_1}^*$$

Since

$$\eta_{p_1}(x_1) = -\frac{p_1x_1}{\mu}\eta_1 + \frac{p_2x_2}{\mu}\sigma$$

and

$$\eta_{p_2}(x_1) = -\frac{p_2x_2}{\mu}\eta_1 - \frac{p_2x_2}{\mu}\sigma$$

$$dx_1 = \frac{x_1}{\mu} \left[\eta_1(d\mu - x_1dp_1 - x_2dp_2) - \sigma p_2x_2 \left(\frac{dp_2}{p_2} - \frac{dp_1}{p_1} \right) \right].$$

Similarly

$$dx_2 = \frac{x_2}{\mu} \left[\eta_2(d\mu - x_1dp_1 - x_2dp_2) - \sigma p_1x_1 \left(\frac{dp_1}{p_1} - \frac{dp_2}{p_2} \right) \right],$$

and the result follows.

Hence

$$\begin{aligned} \frac{rx_2 + x_1}{rx_2\eta_2 + x_1\eta_1} &= \frac{A(\eta_2 - \eta_1) + \mu B\sigma}{B\sigma(x_1p_1\eta_1 + x_2p_2\eta_2)} \\ &= 1 + \frac{A(\eta_2 - \eta_1)}{\mu B\sigma}. \end{aligned}$$

Thus the condition for the calculated value to be approximately equal to the theoretical value of the elasticity of substitution is that $\frac{A}{\mu}(\eta_2 - \eta_1)$ should be small as compared with $B\sigma$, i.e., that the proportionate change in income, allowing for the income part of the price changes, multiplied by the difference in income elasticities, should be small as compared with the elasticity of substitution multiplied by the difference in the proportionate changes in prices. The question remains whether it is reasonable to assume this condition to be satisfied in certain practical cases.

One possible argument is that, when we consider imports from two sources of commodities with the same name, their income elasticities are likely to be approximately equal. This is similar to an argument used by Polak (1950), who gives an analysis which is in some respects similar to the one given above. His two commodities are exports from two countries and his market "the world". He assumes particular forms for the demand equations for the exports of the two countries, and takes into account very simple supply equations in the two countries. He also reaches the result that when $\eta_1 \neq \eta_2$ the usual method of calculation would not give the true

* Considering x_1 and x_2 as functions of p_1 , p_2 , and μ we get

$$dx_1 = \eta_1 \frac{x_1}{\mu} d\mu + \eta_{p_1}(x_1) \frac{x_1}{p_1} dp_1 + \eta_{p_2}(x_1) \frac{x_1}{p_2} dp_2,$$

where $\eta_{p_1}(x_1)$ and $\eta_{p_2}(x_1)$ are the price elasticities of x_1 with respect to p_1 and p_2 .

1951]

elasticity of substitution. He goes on to say that if you consider exports from one country as against exports from the rest of the world, the calculations may be very misleading, but if you consider exports from two similar competing countries, the income elasticities of demand should be approximately equal. Thus the calculated value of the elasticity of substitution should be approximately correct.

When we try to apply this type of reasoning to the sort of cases which we are considering we meet certain difficulties. The *a priori* reasons for approximate equality of η_1 and η_2 would appear to give equally good reasons for an *a priori* expectation of a high value of the elasticity of substitution σ . Thus, provided that the proportionate change in incomes is not very much greater than the difference in the proportionate changes in prices, we would seem to have the best conditions for estimating the elasticity of substitution. But if, when we do the calculation, we find a very low value for the elasticity of substitution, we must come to the conclusion that either our practical methods of estimating have broken down in some way, or our *a priori* reasoning is wrong. If we accept the latter, there do not seem to be good reasons why we should throw overboard the conclusion that the elasticity of substitution is high, while retaining the one that the income elasticities are approximately equal. In any event, it would always be necessary to test whether the proportionate change in income was really not much greater than the difference in the proportionate changes in prices.

We do not, then, think it possible, even in the simplest case, to consider the fitting of a regression of relative quantities on relative prices as equivalent to a case where we have two variates connected by a relation of the form $y_x = \beta_0 + \beta_1 x + \varepsilon$, where ε is an error term reflecting the influence of variables not considered in the simple economic analysis, inconsistent behaviour, etc. It might be possible to put the relation in this form if we allow ε to include the income effects. However, there would then only be a limited sense in which we could regard β_1 as a measure of the elasticity of substitution. The situation which would arise can be seen if we plot "indifference curves" on a graph having as co-ordinates the logarithms of relative quantities and relative prices. Each indifference curve would slope downwards to the right with slope at any point equal to the elasticity of substitution. Income changes would cause a vertical movement on to a different curve; changes in relative prices a movement along the curves. The meaning of the regression line can be seen in various cases:

(1) If there is a functional relation between income and relative prices, all the observations will lie on a curve and, if the relationship is reasonably linear, the regression line will give an approximation to this curve. The conditions for the slope to be positive or negative are similar to those given above for small changes. We shall more frequently expect a negative estimate than a positive one, but it will not necessarily be an approximation to the elasticity of substitution. This is the situation which would arise if there were simple supply equations, with quantity supplied a function of price, as taken by Polak.

2. If changes in income and relative prices are independent, the expected value of the regression coefficient of logarithm of relative quantities on logarithm of relative prices would seem to be some sort of average elasticity of substitution. The coefficient of correlation would be low if income effects were important, and a large number of observations would be necessary to obtain an accurate estimate.

(3) The most important practical case is intermediate between (1) and (2). Owing to the sort of interrelations we get between nearly all economic series, there will not be independence of income changes and relative price changes. Nor will there be perfect functional relationship—supply equations are not as simple as those mentioned in (1). The adequacy of the regression coefficient will depend on the relative magnitude of the different factors involved. We cannot in general assume that the coefficient is a close approximation to the elasticity of substitution. We may also note that, where we are in the situation of case 2, it is the regression of the logarithm of relative quantities on the logarithm of relative prices which is required. The second regression line does not give the required estimate.

When we drop the assumption that there are only two commodities, the situation becomes rather more complicated. First, there seems to be no uniquely accepted definition of the elasticity of substitution. It no longer suffices to define it in terms of proportionate changes of relative quantities over proportionate changes in relative prices as we move along an indifference surface.

The value we get will depend on the direction in which we move along the surface, e.g. Allen (1934) gives three different measures of the elasticity of substitution in the case of three commodities.*

Possibly the simplest definition to take is where the quantities of all goods except the two considered are kept constant. We are then, to a great extent, back to the situation with two commodities with a given amount of money to be spent on them. When we consider actual changes, however, consideration only of the prices of the two commodities and the amount spent on them will oversimplify the analysis, since the "income effects" as then considered would be somewhat different according to how they arose—whether from genuine income changes or from the effects on expenditure on other commodities of relative price changes. The broad outline of our previous results should, however, remain substantially unchanged.†

In fact, when we cease to confine ourselves to the simple theory with only two commodities, we come across most of the usual problems in the application of regression analysis to economic time series. Even if the difficulties due to income effects can be ignored, there will not be a functional relationship between relative quantities and relative prices. There will be other influences, such as changes in other prices, the reaction of price changes in the commodities considered on the consumption of other commodities and those affecting tastes from time to time, such as weather conditions, causing a fluctuation in the relationship. Finally, there may be a steady change in tastes over the period covered by the data. We could consider all these sources of variation as lumped together in an error term and have a relation in the form given above,

$$y_x = \beta_0 + \beta_1 x + \varepsilon,$$

where y is the logarithm of the relative quantities, and x the logarithm of the relative prices. If the conditions under which least squares provides "good" estimates of the parameter β_1 are satisfied, the normal regression procedure would be justified. Unfortunately, as in much work in economic statistics, it is very doubtful whether the conditions are satisfied.

One condition which is unlikely to be satisfied in practice is the one that the values of ε at successive periods of time should be independent. Many of the influences of which one can think will be such that they will cause a certain amount of auto-correlation in the ε 's. Most of the economic influences would probably be of this nature.

A further source of difficulty is that the measurement we obtain for the variable x may itself contain an error. In this case, as is well known, the estimate of β_1 from the simple regression will be biased. This source may well be important for the type of problem which we are considering. Our x is the logarithm of relative prices of imports from two sources. In fact, the data which we use are not price data for homogeneous commodities coming from the two sources, but are "average values" of imports, i.e., are simply total value as recorded divided by total quantity. The average value may well be an average of very different qualities of the commodity, and so may not fit at all well as a price in our simple theoretical framework. Moreover, there will be fluctuations from year to year in the proportion of different qualities in the imports from any one source, and we cannot be at all certain that the variations in the average value series follow closely the variations in prices. In addition, we may feel some doubt whether the total value as recorded is, in all cases, the correct total value for our purpose.

A final condition which may not be satisfied is that ε should be independent of the value of x .‡ There are several possible reasons for the breakdown of this condition. In general, many of the influences we have grouped under ε are economic, and we would expect, from our previous experience with economic time series, that there would be a certain amount of correlation with x . More particularly, however, we see the problem when we consider the "simultaneous equations" complication. When there is a second relation connecting y and x of the form

$$y_x = \gamma_0 + \gamma_1 x + \xi,$$

* J. R. Hicks in *Théorie Mathématique de la Valeur en Régime de libre Concurrence* uses yet another definition, which seems to have little direct connection with the ratio of proportionate changes in relative quantities and proportionate changes in relative prices.

† The situation would, of course, not be improved if we took any of the other possible definitions of the elasticity of substitution.

‡ As mentioned earlier, most of our discussion of the effect of income changes can, from the statistical point of view, be treated as a particular case of the failure of this condition.

1951]

where ξ is an "error term", y and x will be jointly determined by the two equations, their values depending on $\beta_0, \beta_1, \gamma_0, \gamma_1, \varepsilon$ and ξ . x and ε will not be independent, and it can be shown (e.g., Girshick and Haavelmo, 1947) that the regression coefficient obtained by least squares is not, in general, an unbiased estimate of β_1 . Some doubt may be felt about the extent to which a second relationship can be said to hold in the type of data we are using. There seems more justification for assuming a relationship between relative quantities and relative prices on the demand side than on the supply side. In making a decision on how much to supply at a particular price, a producer is unlikely to consider relative prices, in the sense of relative prices of supplies from the two countries, unless there are conditions of oligopoly. On the other hand, we can take the quantity supplied from each source as related to the price received and certain other special variables. When price is the main factor and the supply elasticities are approximately equal, we should expect at least as close a relationship between relative quantities and relative prices as we get on the demand side. Where these conditions are not well satisfied, we may still consider the two supply equations as combining to form a second relation

$$y_x = \gamma_0 + \gamma_1 x + \xi,$$

where ξ may have a large variance. Thus the simultaneous equations complication can arise, and may be important unless the variance of ε is small as compared with that of ξ . The exception involves small "income effects" on relative quantities and little influence from other variables on the demand side (these being the factors governing ε) as compared with the differences in the supply elasticities and the influence from other variables on the supply side (the factors governing ξ).

The conclusion we reach is that, on theoretical grounds, we cannot have very great faith in the meaning of results obtained for the elasticity of substitution by the method under discussion. The regression equation may give us a picture of how relative quantities varied with relative prices for the period of the data—the adequacy of the picture depending on the coefficient of correlation. This sort of result is, however, not enough for the study of the effects, for example, of devaluation, where the interrelations of the variables in the period covered by the data will no longer apply. For this purpose we do want the true elasticity of substitution or some similar measure. The conditions under which the regression coefficient gives a good measure of the elasticity of substitution may apply in particular cases, but the fact could only be established after very careful study—if it could be established at all. We doubt whether the conditions would be satisfied when the data refer to large aggregates, such as the total imports from two countries. There may be greater hope where the data refer to imports of a particular commodity if there are important non-price elements affecting the supply equations. Even here, however, as is indicated by the earlier analysis, the results must be subjected to very careful scrutiny.

3. Calculations Using Simple Regression

It might be useful to consider the results of calculations made for items as given in trade returns. It would be convenient if we could use the results obtained by Kubinski (1950), who carried out investigations for United Kingdom imports from two sources for the years 1921–1938 for 289 commodities. Unfortunately for our purpose, Kubinski's results cover the use of different methods. In order to obtain a better fit (either judged from inspection of a scatter diagram or on the basis of the coefficient of correlation found) he fitted regressions in some cases using a time lag for the reaction of quantities to price (generally a distributed lag), in others deviations from a linear trend, in others deviations from a moving average of varying lengths, and in others separate regressions for different sub-periods. Whatever one may think of the merits of this procedure, it is clear that the results do not provide data for an examination of one method.* It is therefore necessary for us to make some calculations using the method under discussion. The selection of commodities is much smaller than that used by Kubinski, but we think that nevertheless it gives some idea of the type of results obtained.

* This would be true even if the results were given separately for the different methods used, since the results retained for any particular method are a selection which gives more satisfactory answers, in some sense, than the average of results for that method. For this reason, incidentally, the tests of significance used by Kubinski are incorrect, even if there were not the time series difficulties mentioned later.

The data used in our calculations are derived from the Trade Statistics of various countries. The method of selection of the commodities was not consciously connected with the type of result we should expect from our regression analysis. There may, however, be a certain amount of bias in our sample since, as far as possible, we concentrated on commodities which satisfied the four conditions:

- (a) that the value of imports was reasonably large throughout the period considered;
- (b) that there should have been no important change of classification during the period;
- (c) that there should have been no duty on import or, where there was a duty, that it should have been of a sufficiently simple nature for the duty to be allocated to the imports from the different sources;
- (d) that where the value given is f.o.b. the main countries of origin of the imports should be in approximately the same area, so that relative prices c.i.f. and f.o.b. should not differ too greatly on account of transport costs.

The period considered varies, being, in many cases, determined by the major changes in a country's classification of its import statistics. For some commodities the calculation was made for more than one period. The two sources taken were usually two countries, but some calculations were made taking one country against the rest of the world. It must be stressed that the price ratio is really a ratio of average values with all the limitations of such figures. As indicated above, import duties have been added to the average values.

TABLE 1
Regression of $\log \frac{x_1}{x_2}$ on $\log \frac{p_1}{p_2}$

No.	Country of Import	Commodity	Sources	Years	Regression Coefficient	Coefficient of Correlation
1	U.K.	Wheat	(1) Australia and New Zealand	1924-1938	-12.15	-0.76*
2	"	Butter	(2) Argentine.			
			(1) Denmark	1891-1913	+2.02	+0.16
			(2) New Zealand			
3	"	"	(1) Denmark	1920-1932	-1.79	-0.44
			(2) New Zealand			
4	"	"	(1) Denmark	1924-1938	-3.62	-0.69*
			(2) New Zealand			
5	"	Eggs	(1) Denmark	1891-1913	-3.41	-0.30
			(2) New Zealand			
6	"	"	(1) Denmark	1921-1938	-0.57	-0.05
			(2) New Zealand			
7	"	Cotton	(1) U.S.A.	1870-1914	+0.63	+0.26
			(2) Egypt			
8	"	"	(1) U.S.A.	1870-1914	-1.80	-0.71*
			(2) Rest of world			
9	"	"	(1) U.S.A.	1920-1938	-1.91	-0.84*
			(2) Egypt			
10	"	"	(1) U.S.A.	1920-1938	-3.06	-0.73*
			(2) Rest of world			
11	"	Wool	(1) Australia	1920-1938	-0.19	-0.09
			(2) New Zealand			
12	"	"	(1) Australia	1920-1938	-0.60	-0.19
			(2) South Africa			
13	"	Wool: Retained imports only	(1) Australia	1920-1938	-0.50	-0.07
			(2) New Zealand			
14	"	Ditto	(1) Australia	1920-1938	-0.79	-0.22
			(2) South Africa			
15	"	Iron ore	(1) Spain	1870-1886	-4.43	-0.41
			(2) Algeria			
16	"	"	(1) Spain	1887-1900	+4.87	+0.53*
			(2) Algeria			
17	"	"	(1) Spain	1901-1914	-10.21	-0.59*
			(2) Algeria			

1951]

TABLE 1 (Cont.)

18	U.K.	Iron ore	(1) Spain	1870-1914	-8.00	-0.57*
			(2) Algeria			
19	"	"	(1) Spain	1920-1936	-2.46	-0.36
			(2) Algeria			
20	"	Copper ore	(1) Canada	1922-1936	+2.09	+0.61*
			(2) Spain			
21	"	Tin ore	(1) Bolivia	1922-1936	+0.03	+0.03
			(2) Chile			
22	"	Sardines	(1) Portugal	1900-1914	+3.38	+0.80*
			(2) France			
23	"	"	(1) Portugal	1900-1914	-0.86	-0.59*
			(2) Rest of world			
24	"	"	(1) Portugal	1920-1938	-1.43	-0.63*
			(2) France			
25	"	"	(1) Portugal	1920-1938	-0.83	-0.59*
			(2) Rest of world			
26	"	Leather gloves	(1) France	1900-1914	-0.25	-0.06
			(2) Belgium			
27	"	" "	(1) France	1900-1914	+3.09	+0.67*
			(2) Rest of world			
28	"	" "	(1) France	1926-1938	-2.43	-0.84*
			(2) Belgium			
29	"	" "	(1) France	1926-1938	-2.61	-0.94*
			(2) Rest of world			
30	U.S.A.	Coffee	(1) Brazil	1919-1939	+0.48	+0.49*
			(2) Colombia			
31	"	Cement	(1) Belgium	1922-1939	-3.26	-0.40
			(2) Denmark			
32	"	Dead or	(1) U.K.	1920-1939	+0.95	+0.20
		creosote oil	(2) Netherlands			
33	"	Ditto	(1) U.K.	1920-1939	+2.59	+0.61*
			(2) Rest of world			
34	Australia	Tea	(1) Ceylon	1920/1-1937/8	-2.01	-0.47*
			(2) N.E.I.			
35	"	Asphalt	(1) Mexico	1923/4-1937/8	-1.64	-0.42
			(2) U.S.A.			
36	"	Hemp	(1) New Zealand	1922/3-1937/8	-3.16	-0.73*
			(2) N.E.I.			
37	"	"	(1) N.E.I.	1922/3-1937/8	-0.36	-0.17
			(2) Philippines			
38	"	Copra	(1) Solomon Is.	1920/1-1937/8	+3.34	+0.50*
			(2) New Guinea			
39	"	Rosin	(1) France	1922/3-1937/8	-1.21	-0.27
			(2) U.S.A.			
40	"	Newsprint	(1) U.K.	1922/3-1937/8	-9.00	-0.76*
			(2) Canada			
41	Sweden	Motor cars	(1) U.S.A.	1920-1938	-2.57	-0.74*
			(2) Rest of world			
42	"	Syrup	(1) U.K.	1920-1938	-9.07	-0.56*
			(2) U.S.A.			
43	"	"	(1) U.K.	1920-1938	-2.31	-0.33
			(2) Rest of world			
44	"	Type of steel	(1) U.K.	1920-1938	-4.45	-0.66*
		plates	(2) Germany			
45	Canada	Anthracite	(1) U.K.	1922/3-1936/7	-4.76	-0.87*
			(2) U.S.A.			
46	India	Sheet and plate	(1) U.K.	1919/20-1938/9	-1.83	-0.76*
		glass	(2) Belgium			
47	"	Ditto	(1) U.K.	1919/20-1938/9	-2.23	-0.85*
			(2) Rest of world			

The results of the calculations are presented in Table 1. It can be seen that out of a total of 47 results, 36 of the regression coefficients are negative and 11 positive. The coefficients of correlation are also shown. As has been pointed out earlier, the existence of a high coefficient of correlation is not, in itself, evidence that the regression coefficient is the elasticity of substitution. Despite this fact, and although the ordinary test of the coefficient of correlation is not applicable

to time series of this nature, we have thought it worth while to indicate with a star those correlations which on this test would be regarded as significant at the 5 per cent. level. It can be seen that, with the number of observations available, 28 out of the 47 calculations are above this level of significance. The series are not, in general, shorter than those used by most workers in the field.

The results obtained emphasize the need for caution in the application of simple regression analysis of relative quantities on relative prices. Several of the regression coefficients are certainly not elasticities of substitution, and we must retain doubts about the others, even when apparently significant.

4. Introduction of Other Variables

We turn now to consider some of the possible methods of dealing with the problems in the application of simple regression. The first source of difficulty which we might try to eliminate is that due to the income effects on relative quantities. The obvious way to tackle this difficulty is to include income as a second independent variable in our regression analysis. We now obtain the regression equation of logarithm of relative quantities on logarithm of relative prices and logarithm of income. We should then expect our result to give, if there were no other difficulties, an estimate of the elasticity of substitution as the coefficient of the logarithm of relative prices and, roughly, an estimate of the difference between the income elasticities as the coefficient of the logarithms of income. Clearly this procedure will improve the demand equation in many cases. Since, however, the series for relative quantities, relative prices and income will normally be rather highly intercorrelated, there is a considerable risk of an approach to multicollinearity in the sense used by Frisch (1934). In addition, all the other difficulties mentioned earlier still apply. We have made calculations including real national income as a variable for all the commodities previously mentioned where national income data was readily available. The results are shown in Table 2.

TABLE 2

Regression of $\log \frac{x_1}{x_2}$ on $\log \frac{p_1}{p_2}$ and $\log \mu$

No.	Coefficient of Relative Prices	Coefficient of Income	Multiple Correlation Coefficient	No.	Coefficient of Relative Prices	Coefficient of Income	Multiple Correlation Coefficient
1	-10.15	+2.63	0.78*	23	+0.03	-3.32	0.69*
2	+0.03	-4.31	0.87*	24	-1.29	+2.17	0.88*
3	-1.79	-0.48	0.47	25	-1.42	+1.66	0.80*
4	-2.38	-2.12	0.96*	26	-0.54	-0.70	0.28
5	-5.00	+1.84	0.36	27	+0.47	-2.20	0.86*
6	-2.36	-3.02	0.62*	28	-3.19	+1.93	0.87*
7	-0.37	-0.44	0.44*	29	-2.58	-0.10	0.94*
8	-1.17	+0.36	0.72*	30	+0.45	-0.27	0.53
9	-1.67	-0.65	0.87*	31	+0.10	+6.39	0.73*
10	-2.09	-2.23	0.92*	32	+1.35	-0.73	0.29
11	-0.20	-0.22	0.14	33	+2.35	+0.55	0.65*
12	-0.65	+0.60	0.25	34	-1.88	-0.68	0.54
13	-0.48	+1.96	0.31	35	-0.90	+8.32	0.89*
14	-1.01	+2.30	0.58*	36	-2.77	-1.29	0.77*
15	-2.75	-5.55	0.92*	37	-0.47	+1.43	0.40
16	+5.63	-0.97	0.62	38	+2.77	+0.95	0.53
17	+1.95	-8.53	0.91*	39	-1.82	-3.88	0.62*
18	-2.37	-1.94	0.82*	40	-7.97	-1.94	0.76*
19	-2.34	-2.24	0.70*	41	-2.59	+0.08	0.74*
20	+0.33	+6.70	0.87*	42	-2.17	+8.93	0.90*
21	+0.03	+2.22	0.44	43	+0.28	+3.19	0.61*
22	+1.82	+3.98	0.84*	44	-4.05	-1.20	0.67*

It can be seen that there are now 30 negative coefficients for the logarithm of relative prices and 14 positive ones. We have not made an exhaustive test of multicollinearity by the well-known bunch-map technique, but examination shows, in a few instances but not all, that the introduction of the third variate has a harmful effect.

1951]

The second problem with which we can try to deal is that due to changes in tastes, gradual changes in quality of the commodities from different sources, and such other trend factors as disturb the demand relation between relative quantities and relative prices. It is not, of course, true that all trend factors should be eliminated before considering the demand relation. Gradual changes in supply conditions may lead to a trend in relative prices, which in turn leads to a trend in relative quantities when the demand equation remains unchanged. In such a case the existence of the trend would produce very favourable conditions for the measurement of the elasticity of substitution. Unfortunately we should rarely be able to distinguish the two types of trend in practice. There is, therefore, something to be said for attempts to eliminate trend, although to

TABLE 3

Regression Including Time

No.	$\text{Log } \frac{x_1}{x_2} \text{ on } \text{log } \frac{p_1}{p_2} \text{ and } t$			$\text{Log } \frac{x_1}{x_2} \text{ on } \text{log } \frac{p_1}{p_2}, \text{log } \mu, \text{ and } t$			
	Coefficient of Relative Prices	Coefficient of Time	Multiple Correlation Coefficient	Coefficient of Relative Prices	Coefficient of Income	Coefficient of Time	Multiple Correlation Coefficient
1	-10.01	-0.03	0.79*	—	—	—	—
2	-0.13	-0.04	0.83*	—	—	—	—
3	-1.68	-1.40	0.71*	—	—	—	—
4	-2.16	-0.02	0.97*	—	—	—	—
5	-3.41	-0.06	0.96*	—	—	—	—
6	-3.18	-0.03	0.58*	—	—	—	—
7	-0.70	-0.01	0.50*	-0.92	+0.94	-0.02	0.53*
8	-1.74	+0.00	0.71*	-1.83	+2.76	-0.03	0.80*
9	-1.56	-0.01	0.88*	-1.56	+0.03	-0.01	0.88*
10	-1.76	-0.02	0.93*	-1.83	-0.64	-0.02	0.93*
11	-0.28	-0.00	0.25	-0.79	+3.22	-0.03	0.49
12	-0.60	-0.00	0.19	-0.31	+6.40	-0.06	0.57
13	-0.36	+0.01	0.14	-2.99	+16.43	-0.14	0.70*
14	-1.04	+0.02	0.46	-0.74	+6.97	-0.05	0.68*
15	-2.88	-0.60	0.95*	—	—	—	—
16	+5.51	-0.08	0.56	—	—	—	—
17	-0.42	-0.06	0.98*	—	—	—	—
18	-1.80	-0.02	0.85*	—	—	—	—
19	-2.57	-0.02	0.80*	—	—	—	—
20	-0.32	+0.07	0.83*	—	—	—	—
21	+0.03	+0.02	0.38	—	—	—	—
22	+1.57	+0.03	0.85*	—	—	—	—
23	-0.44	-0.01	0.61	—	—	—	—
24	-1.09	+0.02	0.92*	—	—	—	—
25	-1.38	+0.02	0.83*	—	—	—	—
26	-0.42	-0.00	0.15	—	—	—	—
27	+1.33	-0.01	0.76*	—	—	—	—
28	-2.86	+0.01	0.85*	—	—	—	—
29	-2.44	-0.01	0.94*	—	—	—	—
30	-0.09	-0.01	0.82*	-0.12	+0.18	-0.01	0.83*
31	-3.83	-0.01	0.41	+0.24	+6.43	+0.00	0.73*
32	+1.33	+0.02	0.47	—	—	—	—
33	+2.20	-0.01	0.71*	—	—	—	—
34	-1.85	-0.01	0.64*	-1.89	+0.63	-0.02	0.65*
35	+0.40	+0.08	0.78*	-0.42	+6.81	+0.03	0.90*
36	-1.21	-0.03	0.84*	-0.82	+1.16	-0.04	0.85*
37	-1.22	+0.03	0.73*	-1.55	-2.10	+0.05	0.80*
38	+1.34	+0.03	0.62*	+1.05	-1.34	+0.04	0.64
39	-0.97	-0.03	0.58	-1.59	-2.91	-0.01	0.63
40	-5.55	-0.06	0.81*	-6.03	+1.71	-0.07	0.81*
41	-2.52	-0.00	0.87*	—	—	—	—
42	-1.14	+0.14	0.99*	—	—	—	—
43	+2.25	+0.07	0.93*	—	—	—	—
44	-4.53	-0.04	0.75*	—	—	—	—
45	-2.28	+0.06	0.91*	—	—	—	—
46	-1.51	-0.03	0.94*	—	—	—	—
47	-0.99	-0.05	0.98*	—	—	—	—

do so, rather than to try to "explain" the trend, is always in the nature of an admission of defeat. The main difficulty when one tries to eliminate trend is that one has so many possible ways of doing so, and the choice made may considerably affect the results of the later calculations.*

The simplest method of dealing with trend is to include time as a further variable in the demand equation. The results of such calculations for the same commodities as before are shown in Table 3. In these calculations income was not included as a variable. Of the coefficients of the logarithm of relative prices 38 are negative and 9 are positive.

Regression equations were calculated for a few commodities using both time and income as variables. The results are also shown in Table 3, although a warning must be given that bunch-map analysis in these cases might lead to rejection of a high proportion of them.

5. Autocorrelation of Error Terms

A third problem with which we attempt to deal is the possibility of the existence of autocorrelation in the error terms ε of the demand equation. Following the plausible suggestion of Cochrane and Orcutt (1949) that the error terms in many economic relations of this nature are likely to be an autoregressive series of the form

$$\varepsilon_{t+1} = \varepsilon_t + u_t$$

where u_t is random, and that one could thus obtain independent error terms by using first differences of the variables, we have calculated for the same commodities regression equations of the first differences of the logarithms of relative quantities on the first differences of the logarithms of relative prices. The results of the calculation are shown in Table 4. We do not try to present any precise test of the randomness of the residuals when we obtain regression equations, using the figures as they stand and using first differences (see, e.g., Durbin and Watson, 1950). We

TABLE 4

Regression of First Differences

No.	Regression Coefficient	Coefficient of Correlation	$d = \frac{n-1}{n} \frac{s^2}{s^2}$		No.	Regression Coefficient	Coefficient of Correlation	$d = \frac{n-1}{n} \frac{s^2}{s^2}$	
			Original Series	First Differences				Original Series	First Differences
1	-11.95	0.77*	1.40	1.71	25	-1.01	-0.58*	2.42	2.71
2	+0.56	+0.14	0.20	2.27	26	+0.25	+0.09	2.11	2.12
3	-1.22	-0.51	0.93	1.09	27	-0.82	-0.17	2.02	1.82
4	-1.94	-0.80*	0.30	0.18	28	-2.11	-0.64*	1.47	2.64
5	+1.71	+0.28	0.23	2.00	29	-2.32	-0.69*	2.31	3.01
6	-2.00	-0.36	0.43	1.61	30	-0.32	-0.34	—	—
7	-0.79	-0.24	—	—	31	-1.42	-0.28	—	—
8	-1.73	-0.54*	—	—	32	+1.53	+0.45	1.09	1.63
9	-1.80	-0.67*	—	—	33	+1.54	+0.53*	1.76	2.69
10	-2.37	-0.69*	—	—	34	-0.98	-0.37	—	—
11	-0.44	-0.26	—	—	35	-0.64	-0.25	—	—
12	-1.80	-0.48*	—	—	36	-2.52	-0.58*	—	—
13	+0.34	+0.06	—	—	37	-1.28	-0.66*	—	—
14	-2.24	-0.42	—	—	38	-0.96	-0.13	—	—
15	-2.92	-0.55*	0.47	3.23	39	-1.17	-0.31	—	—
16	+8.99	+0.35	0.86	3.58	40	-5.29	-0.50	—	—
17	+2.44	+0.04	0.55	2.91	41	-2.13	-0.66*	1.63	1.65
18	-2.07	-0.36	0.47	2.47	42	-0.96	-0.21	0.34	2.35
19	-1.65	-0.39	0.58	1.58	43	+0.53	+0.14	0.19	0.93
20	+0.36	+0.12	0.76	1.49	44	-3.52	-0.54*	1.92	2.58
21	+1.99	+0.48	1.30	2.52	45	-1.93	-0.23	—	—
22	-0.15	-0.03	1.67	2.07	46	-1.14	-0.75*	—	—
23	-1.45	-0.33	1.18	2.10	47	-1.06	-0.85*	—	—
24	-1.01	-0.57*	0.58	2.52					

* The importance of this point was forcibly brought home to us when we tried to discover the method used by Chang (1948) in his calculations of elasticities of substitution.

1951]

do, however, give the ratio $d = \frac{n-1}{n} \frac{\delta^2}{s^2}$ in the two cases for some commodities and make the guarded comment that, while there may be some gain in randomness, there is not striking evidence that the use of first difference is the perfect solution. It can be seen that, using first differences 36 of the regression coefficients are negative and 11 positive.

6. Simultaneous Equations Approach

The final problem which we tackle is the existence of the simultaneous equations complication. For this purpose we have used a method based on the work on the simultaneous equations approach developed principally by members of the Cowles Commission for Research in Economics.

The first process in the use of the method is the setting up of a system of linear equations or a "model". This model should consist of "structural equations", i.e., equations which are of a basic economic nature such as demand equations, technical production functions, identities, etc. The aim is to estimate such basic equations and not merely relationships which might hold between variates in the period covered by the data. Apart from their obvious intrinsic interest to the economist, such equations are necessary if we are to study the effects of a "change in structure", such as, in our case, exchange depreciation or the introduction of import restrictions.

The model will contain a number of variates which may be split into two groups, one group containing the "jointly determined" variates and the other containing the "predetermined" variates. The latter should not themselves be dependent on the current values of other variates in the model. Some variates, such as yield of wheat per acre, which depends mainly on weather conditions, may be regarded as exogenous to an economic model, and so as predetermined. Others, such as lagged values of some of our series, may be regarded as predetermined though not exogenous. For example, acreage of wheat sown could be regarded as predetermined but not exogenous, for it might depend on the level of prices in the preceding year. The remaining variates should be considered as jointly determined by our system of equations, and we should have sufficient equations to determine them.

Clearly, we should try to include all the important variates in the equations. But it is extremely unlikely that the variates influencing the system can be completely enumerated, and each equation should therefore contain an error term to account for the omitted variates.

When the model is set up it is essential to ensure that the conditions necessary for identifiability are satisfied (e.g., Koopmans *et al.*, 1950). That is, one must make certain it is not theoretically impossible to isolate the equations by an analysis of the data. This involves restrictions on the coefficients of the variates in the equations, restrictions which generally take the form of asserting that certain of the predetermined variates do not enter into a particular equation. For instance, it might be necessary to assert that the output of wheat in Argentina does not enter into the demand equation of the United Kingdom for Argentine wheat.

With various assumptions about the properties of the error terms it is possible to estimate the coefficients of the equations by a method of maximum likelihood. Two methods of doing this have been developed. One makes use of the knowledge of all the restrictions on the coefficients of all the equations in the estimates of each equation (Koopmans *et al.*, 1950). The other makes use in the estimate of any single equation of the knowledge of the restrictions in that equation only, ignoring restrictions in the other equations. This "limited information" method is, consequently, less efficient than the method making use of full information.

Although we in fact estimate all the equations in the models, we have used the limited information method. This was done for two reasons. In the first place, our original intention was to estimate only the demand equations, and the limited information method is well suited for the estimation of a subgroup of equations. In the second place, this method is more likely to be of practical use than the full information method, though even so it involves a very heavy burden of computation.

The principles underlying the computation can be briefly explained. As mentioned earlier, least squares estimates of the structural equations would produce biased estimates of the coefficients. On the assumptions about the error terms we can, however, make least squares estimates of the equations giving each of the jointly determined variates in terms of all the predetermined variates (the "reduced form" of the equations). The problem then is to return from the reduced

form to the structural equations after making the estimates. If one of the structural equations was "just identified", i.e., the restrictions were just sufficient in number to ensure identifiability, the problem presents no great difficulties for then a linear combination of the reduced form equations will give rise to an equation with the correct coefficients equal to 0. If, however, the structural equation was over-identified, i.e., had more restrictions than were necessary to ensure identifiability, it will not, in general, be possible to combine the reduced form equations to give an equation satisfying all the restrictions. In order for it to be possible, it is necessary that the rank of the matrix formed by the coefficients of those predetermined variates not in the structural equation in the reduced form equations involving the jointly determined variates of that equation should be less than the number of rows in the matrix. This has probability zero with calculated values, although it will apply with the "correct" values. It is, then, necessary to make estimates of the coefficients of the original equation (or, equivalently, revised estimates of the coefficients in the reduced form) in a more complicated way which will ensure the correct rank for the matrix. The mathematical derivation of such estimates using maximum likelihood is given in Anderson and Rubin (1949). A detailed description of the calculations involved in the application of the limited information method is given in Girshick and Haavelmo (1947) for both cases where the equations are just identified and cases where they are over-identified.

In the practical application of the method to our problem it is convenient to change the form of the relations which we consider. Throughout we have stressed the disadvantage of working in terms of relative quantities. When we try to set up supply equations it is highly desirable, if not essential, to work with separate quantities, as the supplier is unlikely to take relative prices into account. We have, therefore, set up separate demand and supply equations for imports from the two sources. Incidentally, as the method involves considerable computation, it was thought more useful to experiment with different models for a few commodities than to attempt to deal with a somewhat larger number of commodities.

There are various problems involved in setting up the model. It is frequently impossible to get series for some of the most important variates, which have consequently to be omitted. We have to take some variates as predetermined, such as national income, which should not strictly be considered as predetermined variates at all. It would be possible to treat such variates as jointly determined by a complete set of economic relations, not all of which are included in our subset. We could then, on the basis of results of unpublished work by Chernoff and Rubin, obtain estimates for the subset in the model, leaving out of consideration the predetermined variates in the other equations. This does not, however, seem very satisfactory when the variates left out are those explaining an important part of the influences on demand—such as income. We have, therefore, treated several such variates as predetermined.

A tendency which it is almost impossible to resist in building up a model is to include more variates, on economic grounds, than the number of observations could possibly justify. We fear that the results of this inclination may be only too obvious in some of our models.

The use of the simultaneous equations method does not eliminate all the possible reasons for doubt as to the results of the calculation. It is necessary, for instance, as has been mentioned, to make certain assumptions about the error terms in the relations. The usual ones involve normal distribution, the same probability distribution at each observation, independence at different observations and independence of the predetermined variates. These conditions are unlikely to be satisfied in practice, and, although the work of Chernoff and Rubin, referred to above, suggests that the conditions can, to some extent, be relaxed, we must be cautious in interpreting the results.

A final danger is that the method involves calculating regression equations of the jointly determined variates on all the predetermined variates. With the existence of large errors in so many of our series we are liable to have large errors in the regression equations—and, quite possibly, a close approach to multicollinearity. Even if multicollinearity is avoided the errors in the regression coefficients can lead to very serious errors in the coefficients obtained for the relations we want. There seems to be a particular danger of this sort with data such as we use. The two average value series used are generally highly correlated. Thus their regression equations may well have very similar coefficients. The particular danger can be seen most clearly if we take a "just identified" case. We try to obtain our demand equations by eliminating one or more of the variates in a linear combination of their regression equations. The coefficient of any predetermined variable will only change slowly when a multiple of one average value equation is

1951]

added and the same multiple of the other subtracted. The coefficients of average value in the demand equations—the ones in which we are really interested—are thus very liable to be affected by slight errors. Their sum might remain reasonable but the actual numerical values may be far from correct.

In applying the method, we have used our economic ideas about the signs of the different coefficients as a check on the reasonableness of the results. We discuss at the end of the paper certain statistical tests of the results.

7. Construction of Models for Simultaneous Equations Approach

Ideally, in attempting to analyse demand by this method one would like to have stable demand and supply functions over a period sufficiently long to permit the inclusion of all predetermined variates thought likely to have a significant influence. In those cases where several predetermined variates were involved it would be desirable to have an uninterrupted run of data over three or more decades. This is, in practice, rarely feasible, and the difficulty of meeting this requirement must be regarded as a serious limitation of the method. There is the initial difficulty, which is common to all empirical investigation in the social sciences, that adequate comparable data are hard to come by over so many years. But even where something approaching the desired run of data is available or can be estimated from other series, it has to be borne in mind that the longer the period the more tenuous the assumption that the two functions have remained stable. One or more of several operative conditions are likely to vary over time. Tastes may change, or the quality of the product might be improved as the result of changes in processing, grading or packing. Technical change might lead to the substitution of one factor for another, or even change the form of the supply equation altogether. Two things may be done to reduce to a minimum such causes of instability. In the first place, the period may be chosen so as to avoid upheavals in the economic system, due for instance to a period of war, that would render the assumption of stability in either function *a priori* unpalatable. The last two wars therefore limit the number of years available for these applications, and restrict, in consequence, the complexity of the models. In the second place, care can be taken to select commodities as little affected as possible by abruptly changing influences. On the demand side this clearly points to the avoidance of commodities much affected by fashion, while on the supply side the period chosen should not include a change in the method of supplying. For instance, if there had been a notable lag in adjustment of output owing to a long gestation period, it would be unsatisfactory to carry on the model into a period when this lag was eliminated owing, say, to the operation of a restriction scheme which built up and maintained stocks sufficient to permit of quick adjustments. But providing changes of this type are avoided the commodities chosen could be produced under conditions approximating either perfect competition or monopoly, because it does not affect the stability of the supply function whether producers are "quantity-adjusters" who take market price as beyond their control or "price-adjusters" who do not.

These considerations point to the selection of commodities of staple consumption wherever possible. We took wheat, butter and a variety of steel-plate. It was hoped that the influence of erratic forces would in this way be minimized in our models. But it is not possible to avoid in the use of time-series the influence of general growth factors which are likely to have the effect of shifting either the demand or the supply functions, or both, through time. These must therefore be allowed for in the form of the equation. Perhaps one of the most important of these, certainly one which can most easily be allowed for, is population growth. Here, as elsewhere, it is possible to allow for shifts due to this influence in a number of ways. The shift may be related either to the size of the population or to some function of it, such as its age distribution. The adjustment one seeks is that which returns one most closely to the "equivalent man" of the base year. None of the adjustments is likely to do this exactly, and there appears to be little in favour of taking a complex function rather than simply total size, and the latter was therefore adopted. The quantities to be explained have in all cases been expressed therefore on a *per capita* basis. Consequently, money income in the demand equations had also to be expressed on a *per capita* basis.

It must be acknowledged that this adjustment can be criticized on one score. For it necessarily introduces some distortion on the supply side. Suppliers, it may be said, are never interested in

consumption per head, and this is the way in which quantity is expressed in the equations. Yet it might be argued that the adjustment is mainly a trend factor, and will probably reveal itself by altering the coefficient of any variate in the supply equation which largely reflects growth.

The purpose of the whole inquiry of which this forms the last stage was to investigate the effect on demand of changes in relative prices. The application of the present method, as has been mentioned previously, involved the formulation of a set of demand equations and a set of supply equations. But the focus of interest remained on the coefficients of the demand variates. It is essential to bear this in mind when considering the form of the equations. For whereas the intention was to make the demand equations as complete as the run of years would permit, it was felt sufficient in the case of the supply equations to satisfy two minimum conditions. One was to obtain identifiability of the coefficients of the demand equations, and the other was to include those variates which were thought most important in accounting for variations in the series included in the demand equations. Given this procedure it is clear that we cannot put the same emphasis on the coefficients of the supply variates as on those in the demand equations.

This brings us to the general form of the two sets of equations. In respect of the demand equations there are three problems to face: selection of general economic factors to be included, allowance for influences specifically related to the particular commodity concerned, and relation of the equation to market and not merely to individual demand.

The first of these gives little difficulty on the present occasion, as it is legitimate to take over without justifying them the variates derived theoretically by considering the demand of an individual possessing a given utility function or set of preferences. The variates are: the consumer's income, the price of the good concerned and the price of all other goods. Ideally, the income series should measure personal income after deducting direct tax, i.e., total spendable income. We have used for convenience the rather less suitable net national income at factor cost per head at current prices.

As the problems presented by the three commodities investigated are somewhat different, it is sufficient to note here that the price of other commodities was allowed for by what seemed to be the most appropriate index available. There is one other general point. This arises directly from the nature of our enquiry—an enquiry essentially into the influence of relative prices on demand. This necessitates the separate inclusion of the price of the same commodity obtained from the alternative source. There are always therefore four variates in the demand equations: income per head, the price of the commodity demanded, the price of the commodity imported from the alternative source, and a measure of the price of other commodities. For facility of reference these are called the "necessary" demand variates.

The commodities were chosen so that it would not be necessary to allow for many additional influences peculiar to them or to the period considered. But it is not difficult to think of influences that might have some weight in the mind of the buyer. For example, it might reasonably be urged that in addition to the considerations derived from economic statics, the size of stocks or the relation of the current price to either the price prevailing in the recent past or to some general idea of a long-run normal price are influential factors that should be included, at least experimentally. This point led us to vary the equations on both the demand and supply sides in order to find out the extent to which the other coefficients were altered.

Lastly, there is the problem respecting the relation of our demand equations to the market demand function. We have already dealt with one adjustment which had to be made to market demand in order to obtain our equation for the individual, namely allowance for population growth. There is a further factor which should ideally be brought in, that is an adjustment for changes in the distribution of income. Unfortunately, it is not possible to allow for this variation explicitly owing to the lack of an appropriate measure. This would be a serious limitation if there was reason to believe that income distribution had sharply changed over the period employed. If this did not happen it can again be assumed that a general trend mainly alters the size of any coefficient related to growth.

It remains to examine the nature of the *a priori* expectations with respect to sign and magnitude (or relative magnitude) of the coefficients in the demand equations. Here again it is unnecessary to derive the conclusions theoretically. They may be briefly stated.

The income elasticity of demand will be positive in all cases except those involving an inferior good. This is, of course, tautologous.

1951]

The elasticity of demand with respect to the commodity's own price will be negative in virtually all cases.

The elasticity of demand with respect to the price of the closely substitutable good from the alternative source will normally be positive. This coefficient will probably be less than the coefficient with respect to the commodity's own price on account of income effects.

The coefficient with respect to the average level of all other prices may have either a positive or negative sign, depending on the relative magnitudes of the income effect and the substitution effect. It will be realized that the income effect is likely to be important in this case, because we are dealing with all other goods which are certain to absorb a large proportion of total income.

There is very little that can be said about the absolute magnitude of these elasticities. We should, however, be prepared to find the elasticities with respect to supplies from a relatively small source to be greater than those with respect to supplies from a more important source owing to the greater scope for substitution in the former case. Even when income elasticity, η , is positive, the coefficient with respect to other prices should be greater than $-\eta$. When η is negative the price elasticity should be positive.

It should be noted that as the price elasticities refer to imports from different sources and not to the commodity in general the price elasticities may be quite high. The more closely substitutable the two types considered the higher the elasticities will be.

It has been noted already that our interest centred on the influence of price on demand and consequently the supply equations merely purported to explain the main variations in the demand variates. Even so the supply equations had to account for both total output and for the share going to a particular market. When total output or availability could reasonably be regarded as predetermined it would be satisfactory to include only this series and the price obtained in the importing country in the supply function. But where such treatment could not be sustained the supply function had necessarily to be more complex. This is better treated separately for each commodity.

The *a priori* expectation is that the elasticity of supply will usually be positive, an increased price calling forth an increased supply. But where there is a large income effect of a fall in price it is conceivable that the producer will increase output in order to maintain or at least to moderate the fall in total income. This is particularly likely where the producer is specialized on the commodity in question and has to pay debts fixed in money terms, such as mortgage interest or rent. It is possibly more likely to occur in the case of primary products than of manufactured articles.

Finally, it should be noted that the variates might be expressed in either natural units or in their logarithms. There is little *a priori* reason for choosing the regression slope given by the one rather than that given by the other. There is a slight practical advantage in favour of logarithms, for the coefficients are the elasticities in terms of which economists usually think. However, in this experimental work it was thought worth while to calculate one model in each way. This was done in model IV. Model IVa is in logarithmic form, while model IVb is expressed in natural units.*

8. Model I: Wheat (Australia-New Zealand and Argentina)

Both Model I and Model II investigate the demand for wheat in the United Kingdom, but it is convenient to discuss the two models separately because the differences in source of supply involve differences in the nature of some of the variates. Wheat was chosen as the main staple of consumption. It was, of course, realized from the outset that wheat, like many other commodities, was not a homogeneous commodity but existed in several clearly defined varieties. Schultz (1938, p. 367) has dealt succinctly with the varieties and uses in the following way:

"For commercial purposes the most common and widely used classifications have been those based on the time of sowing, as spring and winter wheat; on the firmness of the grain, as hard and soft; on the products into which they are transformed, as bread and macaroni wheats; and on the colour of the seed, as red and white. Of special importance are the classifications based on the climatic conditions under which the wheat is

* In a note in the appendices will be found the results of simple regressions of relative quantities on relative prices for all the models. For models Ia and IIa there is, in addition, the results of analysis of the demand equations by multiple regression.

grown. The product of humid climates is usually soft and yields starchy flours, while drier climates produce a hard grain that yields a flour with higher protein content. Hard wheat usually gives 'strong' flours, which produce well-risen and light loaves of even texture, and which have a greater capacity for absorbing water in the baking process and hence yielding a larger quantity of bread per barrel—an advantage sought by the baker. Soft wheats, on the other hand, are preferable for pastry, crackers, biscuits, cakes, pies, and for other flaky and crumbly products. In breadmaking they produce a more compact loaf, requiring less shortening. Durum wheat yields a hard granular flour with a larger quantity and different quality of protein than can be obtained from hard wheat, and in strength is intermediate between soft and hard wheat. These qualities render it especially desirable for macaroni and spaghetti.

"To a large extent the different classes of wheat compete with one another in consumption. Although there are consumers who must have a particular class or grade, a larger proportion of the crop is used by manufacturers who can substitute more or less of one class, variety, or quality for another when prices warrant such substitution. In milling it is, therefore, customary to mix different classes and grades of wheat not only for the purpose of meeting the demand for established kinds and qualities of flour but also for the purpose of effecting desired substitutions".

In so far as different varieties are used for different purposes, like bread and biscuit making, or technical requirements set different limits within which different varieties might be combined, it would be desirable to confine attention to those varieties which were or might be used in making the same product. This led to the selection of Australia-New Zealand on the one hand and Argentina on the other. Both are in the southern hemisphere and their crop years more or less coincide; neither produces several well-marked varieties of wheat as is found, for example, in the United States. In addition it appeared that the fair average quality wheat exported from Australia-New Zealand was comparable with Rosafé wheat produced in the Argentine.

Next it was necessary to choose the period. We have mentioned already the desirability of avoiding a period interrupted by war. The choice becomes one therefore between pre-1914 and the inter-war years. While there was a greater availability and probably greater reliability of data for the inter-war years, there were drawbacks from our point of view as well. After 1914 wheat became not only a highly protected commodity throughout the world, but also international trade in wheat was regulated from time to time by various agreements, and output was influenced by the operation from time to time of pools and acreage controls. While data were less readily available for the pre-1914 period, much fewer were needed to represent the supply functions, and these were likely to be more stable. The choice fell therefore on pre-1914, when there was a flourishing futures market and, it is believed, trade approximated to something closely approaching the assumptions of perfect competition. Trade with the United Kingdom was impeded neither by tariffs* nor by exchange controls, and the United Kingdom supply was a small and decreasing fraction of total utilization.

How far back one could go depended on the availability of data. There was no difficulty on the demand side in going back as far as 1870, although if one did go back quite as far it might be necessary to bring in domestic wheat supplies. However, the starting-point was in fact determined by the availability of production series for Argentina. Official figures begin in 1890, and while estimates have been made for the previous five years by the Food Research Institute of Stanford University (in *Wheat Studies*, Vol. IX, No. 7, April, 1933, pp. 239-274), it appeared, on balance, advisable to confine ourselves to the official series. Unfortunately it was impossible to obtain an uninterrupted run of years to 1914, as exports from Australia-New Zealand were either *nil* or negligible, owing to droughts, in the four years 1896, 1897, 1898 and 1903. When exports were *nil* it is clearly impossible to obtain an average value figure. The quantity figure in the years when exports were negligible could not be used because we use logarithmic equations as approximations to the form of the demand equations, and this may only be regarded as reasonable providing fluctuations do not make the variates negligible. Much the same difficulty would be encountered whatever simple form was adopted, but it might not be quite as obvious as when the method produces variates approaching minus infinity.

* There was a small duty on the import of wheat from April 15th, 1902, until June 30th, 1903.

1951]

In formulating the demand equations it is convenient to distinguish between what have been called the necessary variates and the others, the optional ones. The first appear in all four sets of equations, while the others provide the variations on Model Ia. It has been noted previously that the necessary variates are four in number: income, the commodity's own price, the price of the same commodity from the alternative source, and the price of all other commodities. At this point attention need be paid only to the last of these. Wheat is a raw material and not, therefore, bought by the final consumer directly. The final consumer is not concerned with the prices of the various types of wheat. We must think in terms of the demand of the wheat importer and miller. But it probably makes little difference in this case to the way in which we represent the price of other goods. Either way the cost of living index is probably the most appropriate indication available, and this has been used in all cases.

Several other influences may be thought sufficiently important to warrant separate representation. The wheat importer may take the size of stocks on hand into account, in particular stocks available just before the next crop is ready for shipment. For southern hemisphere suppliers this may be around the beginning of January. The stocks should include flour on hand as well as wheat, otherwise fortuitous changes in the amount of wheat on hand that had been processed would introduce a distortion into the series from the present point of view. Fortunately such a series is to be found in J. E. Beerbohm's *Evening Corn Trade List* for the period we are interested in, and it is in the form we require, namely, stocks of wheat and flour in first hands in the United Kingdom. Thus it is concerned with stocks in the hands of sellers rather than that of the buyers, i.e., the millers, and is more reliable than any series which includes stocks in second hands as well, which were largely guesses. This series has been added to the necessary variates to give model Ib. An inverse relationship is to be expected between size of stocks and quantity currently demanded, i.e., less being bought when stocks are high than when they are low. So the coefficient should be negative. Stocks appear to have varied sharply from year to year, though without any noticeable trend. The biggest absolute variation from one year to the next took place between January, 1894 and January, 1895—from a level of 3.24 million quarters of 480 lb. to 1.82 million quarters. Total wheat imports into the United Kingdom from all suppliers were 70.13 million cwt. in 1894, but increased to 81.75 million cwt. the next year. These are changes in the direction we would expect. But when we look at imports from the two sources treated in model I we find that imports were in both cases higher in 1894 than in the next year. This is the kind of variation which is likely to arise when only part of total supplies is related to total stocks, and must be borne in mind in interpreting the results in model I. Furthermore, the size of stocks may more strongly affect the demand for wheat from one source or of one variety than total demand. The coefficient will then be greater than the coefficient (in model II) with respect to rest of the world wheat. In either case the absolute size of the coefficient is unlikely to be high, for at the beginning of the period stocks did not exceed at their highest 23 per cent. of total imports, and whereas total imports show a rising trend, there is no such trend observable in the case of stock-holdings.

The importer may take something more than the current price of the two supplies of wheat into account in deciding his current demand for either. The level of past prices or the trend of prices might also enter his calculations. It is, of course, very unlikely that any particular relationship would be consistently used or very precisely formulated. Yet it is interesting to experiment with past prices as a separate variate. In the case of an annual crop it is reasonable to take the previous year's price, and this has been done in model Ic. In the final variation, model Id, both stocks and the previous year's price have been added to the necessary four variates of model Ia. These are the four sets of demand equations in this model.

With respect to the commodity's own price in the previous year current demand may be expected to move positively. For if the price in the previous year was low more is likely to have been bought than was currently required, and the resulting increase in carry-over is likely to reduce demand below what it might otherwise be. A possible reason for the movement to be in the opposite direction is that when the price of one type has continued to be low for some time adjustments may be made, for instance in the nature of flour produced, so that more of the low-priced wheat will be used. This kind of adjustment will naturally require some time before it is put in hand. In the short run there would be a reluctance to do it if, as is apparently to some extent the case, millers prefer to produce a consistent quality of flour. But in-so-far as such an adjust-

ment is made, a low price of a particular variety of wheat in a previous year would lead to an increase in demand in the current year. In-so-far as importers do not anticipate such a lagged effect of the price change a negative relationship may be carried over into the demand equation. With a market as highly organized as the market in wheat this second appears a somewhat unlikely possibility.

If it was the price of the alternative variety that was low in the previous year more would have been bought from the alternative source, and if, as may reasonably be supposed, storage space was either limited or increasingly expensive, this might tend to decrease the amount bought from the first source, i.e., with respect to the price of wheat from the other source current demand is likely to move negatively. It is not easy to suggest limits for the sizes of either of these coefficients, but they are unlikely to be very high.

It will be realized that when we have in our demand equations both stocks and lagged prices, the effects just considered will be confined to the proportion of stocks which come from the different sources. This will affect the magnitude of the coefficients but not their sign.

Now we turn to the supply equations. It will be remembered that the supply equations were intended only to explain variations in the demand variates, and not fully to reflect general supply conditions. The supply we are concerned with is supply to the United Kingdom, and one of the terms must therefore be the current price in the United Kingdom. The other constituents are not immediately obvious. We must, to begin with, decide whether total supply can rightly be regarded as wholly predetermined. Total output depends on acreage sown and yield per acre. Acreage is necessarily decided at the beginning of the crop year and so can be considered as predetermined, whilst yield depends on weather and other exogenous influences. Production might therefore be regarded as wholly predetermined. For our purpose it is unnecessary to include acreage and yield separately; it is sufficient to use total output. This in itself is incomplete, for what we are concerned with is not production but availability, and this differs from output to the extent of changes in stocks. In his analysis of the disposition of American wheat Holbrook Working came to the following conclusion:

"Changes in year-end stocks of wheat have played an equal part with variations in exports in absorbing the fluctuations in the crops. On the average the excess supplies from a large crop are absorbed nearly one-half by increased exports and one-half by additions to stocks, while the deficient supplies from a short crop are met about one-half by increased imports and reduced exports and again one-half by drawing down stocks. . . . It becomes clear that an accurate judgment of the supply and demand situation in any year, the need for complete and accurate information on year-end stocks of wheat is nearly as great as the need for accurate statistics of production". ("Disposition of American wheat since 1896, with special reference to changes in year-end stocks", *Wheat Studies*, Vol. IV, No. 4, 1928, p. 136.)

There is thus a *prima facie* case for allowing for carry-over. Stocks may be regarded as a predetermined endogenous variate in our system. Therefore our supply term combines total production and total stocks. The source of the data used and the nature of the adjustments made are described in a note in the appendices.

Both coefficients should be positive. A rise in the United Kingdom price would be expected to raise supplies and a fall to lower them. Similarly, a larger crop makes more available for export and a smaller crop reduces availabilities.

Model Ia

For model Ia the equations are:—

Demand for Australian-New Zealand wheat:

$$y_1 = \alpha_1 y_3 + \alpha_2 y_4 + \alpha_3 z_1 + \alpha_4 z_2 + \epsilon_1. \quad \text{(Equation 1)}$$

Demand for Argentine wheat:

$$y_2 = \beta_1 y_3 + \beta_2 y_4 + \beta_3 z_1 + \beta_4 z_2 + \epsilon_5. \quad \text{(Equation 5)}$$

Supply of Australian-New Zealand wheat:

$$y_1 = \gamma_1 y_3 + \gamma_2 z_6 + \varepsilon_9. \quad \text{(Equation 9)}$$

Supply of Argentine wheat:

$$y_2 = \delta_1 y_4 + \delta_2 z_7 + \varepsilon_{13}. \quad \text{(Equation 13)}$$

Both the meaning of the various terms and the values and signs of the corresponding coefficients (which are the elasticities we seek) are set out in Table 5 (p. 343). For facility of reference to the Table the equations are numbered.

It will be seen that the elasticities of demand with respect to the commodity's own price and with respect to the price of the alternative supply are of the expected sign in both demand equations. While the responsiveness of demand to price changes varies considerably for the two sources, there is in either case similarity in magnitude between the straight and cross elasticities. The income elasticity of demand for Australian-New Zealand wheat is negative, which would be the case if the good was inferior. The coefficient with respect to the cost of living index turns out to be positive as expected. The values in both cases are somewhat higher than might be expected. Argentine wheat comes out as a normal good for its demand varies directly with income, and we obtain a negative sign for the coefficient with respect to the price of other goods. Again the actual magnitude of the elasticities is greater than might be expected.

The elasticity of supply comes out as negative for both sources, while the other coefficients in the supply equations have the expected signs. The coefficients with respect to output plus stocks is perhaps higher than one would expect.

Model Ib

For this model stocks of wheat and flour in first hands in the United Kingdom at the beginning of January each year are introduced into each of the demand equations (z_5). The equations are otherwise as in model Ia. For the values and signs of the coefficients see Table 5 (Equations 2, 6, 10 and 14).

The straight and cross price elasticities in both demand equations are much bigger than in model Ia, but again the straight and cross elasticities for each source are of comparable sizes, and the elasticities relating to the demand for Argentine wheat are much higher than those relating to Australian-New Zealand wheat. However, the signs are wrong in the first demand equation with respect to both prices. The income elasticity has also changed sign as compared with model Ia, and the suggestion that this wheat might be "inferior" is not sustained. The income term in the Argentine demand equation, is again positive and the coefficient of other prices is again negative. The new variate introduced has the expected sign in both cases, and it shows once more the demand for Argentine wheat as the more responsive.

There is no change in sign compared with model Ia in the coefficients of the supply equations nor any significant change in size. It still appears that supply varies inversely with United Kingdom price.

Model Ic

For this model the price (or average value) of Australian-New Zealand wheat (z_3) and the price (or average value) of Argentine wheat (z_4) in the preceding year are brought into each of the demand equations. The equations are otherwise as in model Ia. For the values and signs of the corresponding coefficients see Table 5 (Equations 3, 7, 11 and 15).

In the first demand equation the straight and cross elasticities are once again of the wrong sign. Income elasticity is again positive, but the coefficient with respect to the price of other goods is now negative, and greater in magnitude than the income elasticity. The signs of the coefficients respecting the previous year's prices do not improve the picture, for both are positive. In the second demand equation the signs of the first three coefficients are as expected, while demand is shown to have an inverse relation with respect to the price of all other goods and is again too large. But in the case of the new term, lagged prices, we find the expected set of signs. The sizes are in all cases somewhat higher than might be expected.

There is again no change in the sign of the coefficients of the supply equations.

Model Id

In this model both lagged prices and stocks of wheat and flour are included in the two demand equations. The equations are otherwise as in model Ia. For the values and signs of the coefficients see Table 5 (Equations 4, 8, 12 and 16).

Once more the straight and cross elasticities in the first demand equation are of the wrong sign, and the coefficients with respect to the price of other goods have too great a negative value to be accepted. Only the income term and the coefficient with respect to stocks have the expected signs. Nor are the results in the second demand equation wholly satisfactory. The two price elasticities are of the expected sign and much smaller than on previous occasions, although still quite high. The coefficient with respect to the price of other goods is again negative and too large, while the coefficient with respect to stocks has the wrong sign. The income elasticity and the elasticities with respect to the pair of lagged prices have the expected signs. In the supply equations there is again no change in signs.

Model I

Taking the four variations in model I together, it is clear that expectations as to the sign of the coefficients have been decidedly less well satisfied in the equations concerning Australian-New Zealand wheat than in the others. In only one model (Ia) do the straight and cross elasticities for Australian-New Zealand wheat have the expected signs, and even there the other demand coefficients are acceptable only on the assumption that the good was inferior. The introduction of stocks and lagged prices did not improve the position. For Argentine wheat we find consistently correct signs for the two price elasticities, but otherwise there is variation.

It remains an open question whether more could rightly be expected. We have seen already that some of the desired terms could be represented only by approximations, and perhaps the way in which the price of other goods was represented was the least satisfactory approximation in the model. It is difficult to see how the series could be significantly improved. This is likely, however, to have been a much less serious shortcoming of the model than a further defect. In model I we considered only availabilities and exports by Australia, New Zealand and Argentina. In this way, it will be remembered, we obtained something approaching a homogeneous quality of wheat. Yet there is no reason to suppose either that these countries were the only producers of this type of wheat, or that the demand for their output was unaffected by availabilities of other varieties. In other words, in order to obtain this approximation to homogeneity we had to ignore a large part of the actual supply of and demand for wheat. It might well be the case that the Australian-New Zealand wheat and the Argentine wheat differed more in type than descriptions suggested, and that supplies from elsewhere competed more strongly with Australian-New Zealand wheat than with Argentine wheat. If this were so it would account in part for the marked difference in results in the two cases. It does in any case suggest that the experiment should be repeated with a better coverage. It was thought better to retain Australia-New Zealand—which gave the less satisfactory results—and drop Argentina for this purpose. There is no reason for suspecting that any important disturbances are introduced by combining the two countries (Australia and New Zealand), and the combination is therefore retained in model II.

9. *Model II: Wheat (Australia-New Zealand and the Rest of the World)*

The intention in this model is to improve the coverage. The coverage would naturally be complete if we took Australia-New Zealand on the one hand and all other suppliers on the other. This has been done. The substitution for Argentina of all suppliers other than Australia-New Zealand raises a few problems. It has been noted already that we have been compelled to represent price in terms of average value, and the latter is certain to be affected by changes in qualities. Such changes will clearly be considerably greater when we move from averaging a particular country's exports to averaging the exports of all suppliers. The so-called price that we obtain cannot bear a close relation to the price which the importer has in mind when making his decision on quantities and sources. Yet such appears to be the only way in which we can proceed.

1951]

The other problem raised by the inclusion of all other suppliers is less serious. It concerns the production and carry-over term in the supply equation. It is impossible to obtain trustworthy annual estimates of either production or carry-over for several important wheat-producing areas in the world from 1890 onwards. This is less important here than might at first appear, because many of the countries for which reliable estimates are not available were not wheat exporters. For the main exporters it is possible to obtain estimates. In model II production and stocks are those for the five main wheat-exporting countries taken together—Russia, the United States, Canada, Argentina and India. Both the sources of the figures and the adjustments that were made are noted in the appendices.

Model IIa

For this model the equations take the same form as in model Ia and need not, therefore, be repeated. The meaning of the terms and the values and signs of the coefficients, which are again the required elasticities, is set out in Table 6 (Equations 17, 21, 25 and 29).

Both sets of price elasticities in the demand equations have the expected signs. Not only are the sizes of these elasticities nearer the level that seems reasonable than was the case in model I, but the relative sizes of the elasticities in the first and second equations also seem reasonable. For a change of 1 per cent. in price is likely to have many times the effect on demand for wheat from one relatively small source than on demand for the rest. In order to accept the income coefficient we must again assume that Australian-New Zealand wheat was an inferior good for the sign is negative; this is not so for rest of the world wheat. While this is an unlikely state of affairs it is not necessarily unacceptable in principle. Furthermore, we have again a negative elasticity of supply for Australian-New Zealand wheat while the other supply coefficients have the expected signs. Their magnitudes seem reasonable.

Model IIb

This model differs from the preceding one only by the introduction of stocks of wheat and flour in first hands in the United Kingdom at the beginning of January each year (z_3) into each of the two demand equations. For the values and signs of the coefficients see Table 6 (Equations 18, 22, 26 and 30).

Again the two sets of price elasticities in the demand equations have the correct signs, the straight and cross elasticities in each equation are of comparable size, and the relative magnitudes of the elasticities in the two equations show a bigger response of demand to a 1 per cent. change of price for Australian-New Zealand wheat than for rest of the world wheat. All this is very satisfactory. So are the signs of the coefficients relating to the price of other goods and to stocks. But the income elasticities in both equations now come out negatively—wheat in general becomes an inferior good if these are to be accepted. On the supply side the coefficients are correct with the exception of the Australian-New Zealand supply with respect to its own price. In this model it will be realized that the series representing importers' stocks is less appropriate than it was for model I, for rest of the world wheat necessarily includes northern hemisphere supplies, which are available from about August 1st to November 30th, and for these supplies a stock figure for about August 1st would be more appropriate. However, an average of the January 1st stocks thought to be appropriate for southern hemisphere crops and August 1st stocks for northern hemisphere crops has more serious limitations than the retention of the January figures. This may in part account for the size of the coefficient with respect to stocks in the second demand equation.

Model IIc

The equations are as in model IIa, except that the price of Australian-New Zealand wheat (z_3) and the price of rest of the world wheat (z_4) in the preceding year are brought into each of the two demand equations. For the values and signs of the coefficients see Table 6 (Equations 19, 23, 27 and 31).

The introduction of lagged prices has not upset the signs of the two price elasticities in the demand equations, but has altered both the sizes of them with respect to one another in each

equation and with respect to the other pair. The sizes on both counts must be regarded as less plausible than before. Both income elasticities now become positive, suggesting wheat is a normal good, but both coefficients with respect to the price of other goods are negative and of a greater magnitude than that of income. Demand is shown to move positively with respect to both lagged prices, while negative elasticities of supply appear in both supply equations. For the rest of the world it must be remembered that average value is a rather worse measure of price than for a single country. Its employment as a lagged variable is even less satisfactory than its use as a current variable owing to change in proportions from different sources.

Model IIa

Both lagged prices (z_3 and z_4) and stocks of wheat and flour in first hands in the United Kingdom at the beginning of January each year (z_5) are included in the two demand equations. Otherwise the equations are as in model IIa. For the signs and values of the coefficients see Table 6 (Equations 20, 24, 28 and 32).

Again the signs of the two pairs of price elasticities are correct, but their relative magnitudes are not very satisfactory. The two income elasticities are now positive, and so is the coefficient with respect to the price of other goods in the first equation, though not in the second. Three of the signs of the coefficients with respect to lagged prices are as expected, and the relation between current demands and importers' stocks is shown to be negative in each equation. In both supply equations we have negative elasticities of supply, but the expected signs with respect to availabilities.

Model II

Taking the four variations in model II together, it is noticeable that in all cases the signs of the straight and cross elasticities are satisfactory, and in two of the variations their sizes both with respect to one another in the same equation and with respect to the pair in the other equation appear highly plausible. There are, however, some peculiar features. The income elasticity changes sign in both demand equations, while the Australian-New Zealand supply elasticity remains perverse throughout. The introduction of lagged prices similarly upsets the sign of the supply elasticity in the second equation, though the introduction of stocks is uniformly helpful. It might be said, nevertheless, that the increase of coverage has considerably improved the results for the Australian-New Zealand demand.

It should, however, be borne in mind that these economic "tests" of the models are not conclusive. It is necessary to enter this caveat, for when the statistical tests are applied it might well turn out that all these changes are insignificant because of the large standard errors in the estimates.

10. *Model III: Steel-Plates into Sweden*

It was felt that the next experiment should introduce two variations, in the first place to take a manufactured product instead of a primary product and in the second place to bring in the United Kingdom as supplier instead of as importer. The general considerations in choosing the commodity and importing country remain, of course, exactly as before. In respect of manufactured products there is perhaps more danger of the quality or design changing significantly and leading to instability in the demand relation. But this is possibly more likely of finished than of semi-finished products, and it was decided therefore to select an industrial raw material. For each type of these there are innumerable varieties, and it was clearly desirable to limit attention to one particular variety as far as possible. In addition it was necessary to find a variety for which the United Kingdom was one important supplier, and there was at least one other important source for which the necessary data could either be found or calculated. With an industrial raw material it is improbable that changes in fashion would be important, though it is quite possible that demand might be affected erratically through the imposition of quantitative or exchange controls on the part of the importer. If this happened little purpose would be served by an attempt to investigate the influence on the size and distribution of demand exerted by changes in relative prices. Clearly it had to be avoided. For the importing country the necessary income and other data had again either to be available or calculable.

These requirements appeared to be satisfactorily fulfilled by a product imported by Sweden

1951]

from both the United Kingdom and Germany. The product appears under a separate classification in the Swedish tariff list and trade returns. From 1920 to 1929 it was item number 735A and from 1930 item number 1407, and is given as: Steel-plates, cut or uncut, without grinding or polishing and without outer-covering, other than cold-rolled, of less than 3 millimetres but not less than 0.6 millimetres thickness, right-angled. The lighter gauges of this blackplate are used for components for the electrical industry, metal boxes, the canning industry, toys and, to a lesser extent, in the motor industry, while the heavier gauges are used for steel tanks and containers, railway wagons, ducting and cowlings for ventilating systems and air-conditioning plants, cooking and heating equipment and appliances where synthetic paint, not vitreous enamel finish, is required. The demand is as much consumption demand as investment demand and consequently it appears reasonable to employ a series for personal income rather than investment outlay in the demand equation.

For this model it was decided to take the inter-war period, beginning in 1920 and ending with the last full peace year, 1938. One difficulty arose. This was due to the German hyperinflation of the early 'twenties, which led during 1923 to the collapse of the currency and just before that to the rise of foreign currencies in terms of the German mark to astronomic heights. As our prices had to be in terms of Swedish kroner it was impossible to include a year when the relation between marks and kroner became meaningless and 1923 had therefore to be omitted. However, it seemed that despite developments in the second half of 1922 the series for the latter year was not rendered unusable. Only 1923 was therefore omitted.

We have seen previously that there are four variates which must be included in the demand equations. They are income, the commodity's own price, the price of the commodity from the alternative source and the price of all other commodities. The general considerations here are precisely those discussed at the beginning of the account of model I and need not be repeated in detail. Quantities were again expressed on a *per capita* basis and so had income to be. We estimated, in the manner described in a note in the appendices, net national income at factor cost in current prices per head of the population. Again, the commodity's own price and the price of the commodity from the alternative source had to be obtained from the trade returns, and had to take the form of average values.

The demand we are directly measuring is again that of the importer rather than that of the final consumer. In this case it is likely that the manufacturer imported directly. This affects the manner in which the price of other goods is to be best represented. It is unlikely that movements in the cost of living index, with its heavy weighting on food, clothing and rent, would be the most appropriate measure of movements in the price of other goods. A more appropriate measure would be the movements in the price of industrial raw materials generally. An index of such prices was therefore used to represent the price of other goods and act as deflator.

With the relatively short run of years at our disposal considerable discrimination was required in selecting other variates in order to avoid overloading the model. Nevertheless it was felt that one further influence merited separate representation. That was the growth of domestic supplies of sheet of similar gauge over the period. The nearest item we could obtain figures for was sheet of a thickness of less than 3 millimetres. Aggregate production rose fairly steadily from a level of 23,100 metric tons in 1920 to a level of 85,500 metric tons in 1938. Unfortunately it proved impossible to obtain a satisfactory price series, and the quantity series itself had to be included. This would act as a trend factor reducing the level of imports below what they otherwise might be.

These five variates constitute our demand equations. As noted previously we should expect to find the coefficient with respect to income to be positive—there appears little reason to doubt that we are concerned here with a normal rather than an inferior good. The coefficients with respect to the commodity's own price should be negative, and that with respect to the price of the good from the alternative source should be positive. The coefficient with respect to the price of "other goods" might be either positive or negative. The coefficient with respect to domestic output should show a negative sign because, as just stated, increases in such supplies would reduce the demand for imported supplies below what otherwise they might be. But in so far as much the same trend was present in quantities the sign might merely reflect this and be positive in consequence.

As in the previous models our main interest centred on the demand variates, in particular on

the influence of changes in relative prices. So once more the supply equations were intended merely to account for changes in the demand variates. Even so the problem could not be disposed of quite as easily as in models I and II. For supply could not be taken in the same way to be wholly predetermined. Yet the commodity considered was in itself of relatively small importance compared with the output of the industries concerned and a fairly simple function might be justified. It was decided therefore to represent the supply conditions with only two variates—an index of wage rates and an index of productivity in the relevant parts of the industry. The first required adjustment for the demand variates were in terms of kroner, and during the period the exchange value of the kroner in terms of both sterling and marks varied. Hence the index of wage rates for the United Kingdom and for Germany were adjusted for changes in the foreign exchange value of sterling and marks in terms of kroner. The indices of productivity had to be estimated. The method of estimation of each is set out in the appendices. It is sufficient here to note they are at best very approximate. In the present case these may be regarded as endogenous predetermined variables in the system. In addition we required the price of the commodity supplied in each equation.

The sign of the price variate would be expected to be positive, more being supplied when the price rose and less when the price fell. With a rise in wage rates supply would be expected to fall and with a fall in wage rates to rise, i.e., an inverse movement and therefore a negative sign. Increases in output per head would be expected to increase supplies available, and therefore the coefficient with respect to the indices of productivity should be positive in both cases.

It was necessary to include one more series in the supply equations, for throughout the period importation of this commodity was subject to a specific duty of 4 kroner 50 öre per 100 kilogrammes. This naturally caused the price to the supplier to differ from that to the purchaser. Given the form of the equations this had to be allowed for, perhaps somewhat unsatisfactorily, by inserting into each supply equation a series obtained by expressing price with duties as a percentage of price without duties for each supplier. These are given the same coefficient in the supply equation as that for the price, but with the opposite sign.

For model III the equations are:—

Demand for United Kingdom steel-plate:

$$y_1 = \alpha_1 y_3 + \alpha_2 y_4 + \alpha_3 z_1 + \alpha_4 z_2 + \alpha_5 z_3 + \epsilon_{33}. \quad \text{(Equation 33)}$$

Demand for German steel-plate:

$$y_2 = \beta_1 y_3 + \beta_2 y_4 + \beta_3 z_1 + \beta_4 z_2 + \beta_5 z_3 + \epsilon_{34}. \quad \text{(Equation 34)}$$

Supply of United Kingdom steel-plate:

$$y_1 = \gamma_1 y_3 + \gamma_2 z_4 + \gamma_3 z_5 - \gamma_1 z_6 + \epsilon_{35}. \quad \text{(Equation 35)}$$

Supply of German steel-plate:

$$y_2 = \delta_1 y_4 + \delta_2 z_7 + \delta_3 z_8 - \delta_1 z_9 + \epsilon_{36}. \quad \text{(Equation 36)}$$

For the meaning of the terms and the values and signs of the coefficients, which are again the elasticities we are interested in, see Table 7.

Taking the demand equations first, it will be seen that both price elasticities in each equation have the expected signs, the straight elasticities are negative and the cross elasticities are positive. The straight elasticities are also of much the same size, not an entirely unpalatable magnitude, but this is not so for the cross elasticities. The price of German supplies appears to be a stronger influence than the price of United Kingdom supplies in both equations. The relative magnitude of the straight and cross elasticities in the United Kingdom equation are much less plausible than the relation found in the German equation. We find a positive sign with respect to the price of industrial raw materials, though the sizes of the coefficients differs substantially between the two equations. Both the coefficients with respect to income and with respect to domestic supplies of sheet have the opposite signs to those we would expect to find, and their magnitudes are also somewhat higher than might be expected. Of course, with respect to output of sheet it must be admitted that we may have no more than a trend factor, and less emphasis can be placed on the sign of this coefficient than on that with respect to *per capita* income. It is most difficult

[1951]

to believe that the sign of the latter is in any way associated with the method of representing income used in this model.

As before, less emphasis can be placed on the coefficients in the supply equations. It is none the less surprising that for the United Kingdom the elasticity of supply with respect to price should be negative rather than positive. In the German supply equation this coefficient has both the expected sign and a reasonable magnitude. The coefficients with respect to wage rates come out positive instead of negative in both equations, whilst in the United Kingdom equation the coefficient with respect to productivity is negative instead of positive though it has the expected sign in the other equation.

It will be realized that the span of years was not long for so many variables and there are inevitable shortcomings of the index numbers. How far these affected the nature of the results it is not possible to say. It might be noted also that whereas in the case of wheat and butter we are justified in assuming competitive conditions so that the producers could not control prices it is not obviously the case here that prices were determined without considering the price of the foreign supplier.

11. *Model IV: Butter into the United Kingdom*

In this model we do not repeat with a different commodity what has been tried in the previous models. Two new variations are introduced. Firstly, we try in successive stages differing assumptions with respect to supply conditions, and secondly, we compute the same series twice, once taking a logarithmic form for the equations and then expressing the variates in natural units. It is therefore necessary to take the supply equations for models IVa and IVb together and those of models IVc and IVd together. There are differences of a slighter kind in the form of the demand equations also. It is more convenient therefore to deal separately with the two pairs.

The previous models have one common feature: they all relate to raw materials. It was felt that our experiments with this method should include at least one commodity bought directly by the final consumer so that we might have the opportunity of representing his demand function. Apart from that our selection was limited only by the need to fulfil the various general requirements outlined on previous pages. Butter imported into the United Kingdom over the inter-war period appeared to be one commodity having all the requirements. There were two important sources of supply, Denmark on the one hand and Australia-New Zealand on the other. It was realized that there were quality differences between the imports from the two sources. Danish butter was in general more favoured because of its creamier nature, a feature apparently related to the higher acid content permitted by quicker delivery over the much shorter distance between farm and shop than in the alternative case. It was, as in models I and II, more satisfactory to tie Australia and New Zealand because they were both important suppliers and supplied much the same quality of butter.

The period chosen had no interruptions such as were encountered previously, but towards the end of 1936 the New Zealand Government inaugurated a scheme whereby the proceeds of a levy on domestic sales of butter were used to subsidize producers selling in oversea markets. It did not prove possible to get a formula whereby this divergence between receipts to producers and United Kingdom prices could be allowed for. It was therefore necessary to curtail the period by omitting the years 1937 and 1938. So the period runs from 1920 to 1936 inclusive, a fact which had to be kept well in mind in choosing variates.

Models IVa and IVb

As before, we have the four necessary variates in the demand equations, namely, income, the commodity's own price, the price of the commodity from the alternative source and the price of all other goods. The general considerations here are precisely as discussed at the beginning of model I and need not be repeated. Quantities were again expressed on a *per capita* basis and so had income to be. We obtained from the same source as for models I and II an index of net national income at current prices per head of the population. The commodity's own price and the price of the commodity from the alternative source again took the form of average values. As in this case the demand we were investigating was that of the final consumer, the cost of living index appeared to be the most appropriate indication of the price of all other goods bought.

Even with the relatively small number of observations at our disposal it was felt that these four variates should be supplemented by a fifth. For it was felt that there was one other major influence on the demand side, that is, the price of better quality margarine. During the inter-war period this was generally regarded in the United Kingdom as an article which competed keenly with the cheaper qualities of butter. A price series for better quality margarine is collected for inclusion in the cost of living index and this series was added as a fifth variate. It is possible to question whether this price can reasonably be regarded as wholly predetermined. The answer is that the price of margarine must in part be affected by the price of competing grades of butter via consequential variations in the output of margarine. The choice becomes one of regarding this variate as sufficiently predetermined to warrant inclusion *tout seul*, or providing a secondary supply equation to account for variations in the price of margarine. When the latter possibility was explored it was found that data were not available for the formulation of a satisfactory supply function, and consequently the price of margarine had, if it was to be included at all, to be treated as though it were wholly predetermined.

These are the terms in our demand equations. As noted previously, the coefficient with respect to income might be either positive or negative, being more likely to be positive for a commodity like butter in general though not necessarily for each grade; the coefficient with respect to the commodity's own price should be negative, the coefficient with respect to the price of all other goods might be either negative or positive. A positive sign would be expected in the case of the coefficient of the price of margarine. As we are dealing with two clearly marked qualities of butter we would expect to find the shift greater for the cheaper than for the better quality butter, i.e., for the size of the coefficient in the Australian-New Zealand demand equation to be greater than that of the coefficient in the Danish demand equation.

The supply functions in models IVa and IVb were based on the hypothesis that total milk output could be taken as an exogenous predetermined variable. We started therefore with such a series for each of our two sources. Next it was necessary to add a variable which would determine the proportion of this total which was turned into butter. Where data are available on conversion costs incurred in processing we have the necessary variable. This was so for Denmark. The series had to be converted into sterling in order to allow for exchange rate movements, which would otherwise render it unsuitable to be taken in conjunction with sterling prices. The supply available for the United Kingdom depended on the price prevailing in the United Kingdom, which had to be included in the equation, relatively to prices in the other two main markets, Germany and Denmark itself. Owing to exchange control and trading agreements supply to Germany could not for the whole of the period be regarded as a function of price, and this had, consequently, to be ignored. But domestic demand rose sharply in the 'thirties after the Government put a tax on some of the ingredients of margarine and so raised the price of the latter. Hitherto consumption per head of margarine in Denmark had been one of the highest in the world, and one of the measures for dealing during the depression years with the difficult marketing problem for butter was therefore to encourage greater domestic consumption. The figures of consumption per head suggest this effort was highly successful. Therefore it was decided to add the price of vegetable margarine in Denmark, again converted into sterling at the current rate of exchange. So in the Danish supply equation we have four variates: the price of Danish butter in the United Kingdom, total milk produced in Denmark, conversion cost from milk to butter in Denmark deflated by the sterling-kroner exchange rate, and the retail price of vegetable margarine in Denmark deflated by the sterling-kroner exchange rate. There was one further adjustment that had to be introduced. From 1932 onwards there was a duty of 15s. per cwt. on butter imported from Denmark. This brought a divergence between the United Kingdom selling price and the price relevant for the Danish supply equation and had to be subtracted from the United Kingdom price. In model IVa this was allowed for by expressing price with duties as a percentage of price without duties for each supplier as in model III. In model IVb it could be put simply at the rate of 15s. for the years 1932-36 and zero for the preceding years.

We should expect the coefficient with respect to the price of Danish butter to be positive, more being supplied at a higher than at a lower price. Similarly an increase in milk output would be expected to increase supply and a fall to lower it, and so the coefficient with respect to milk output would be expected to be positive also. A negative sign would be expected in the case of the

1951]

coefficient with respect to conversion cost, a fall resulting in a greater proportion of milk being processed into butter and a rise resulting in less. Finally, the coefficient with respect to the price of vegetable margarine would be expected to have a negative sign. An increase in the price of margarine would lead to the consumption domestically of more butter, and so to a drop in supplies available for export, while a fall in price would lessen the home demand for butter.

We have so far only two variates in the Australian-New Zealand supply equation, namely, the price obtained in the United Kingdom and total milk output. Unfortunately it proved impossible to obtain for the whole period strictly comparable conversion series for the two countries involved. In the case of these two countries it was not so much alternative export or domestic butter consumption that appeared to be important. Both produced for the United Kingdom market in the main and in neither was margarine consumed. So an equation in the same form as that for Denmark was not required. One factor important in determining the proportion of milk output processed into butter apart from the prevailing price of butter was the prevailing market for cheese, as both countries were also important cheese exporters. It was decided therefore to include a variate which represented the ratio of the price of butter to the price of cheese. Clearly it was not satisfactory to take the current ratio of the two prices for the decision respecting proportions of milk processed in butter and cheese would be taken on the basis of some past price relationship. As little apparatus is apparently involved and in view of the high year-to-year variations in both totals and proportions of butter and cheese produced, it was decided to take the ratio of the price of butter to the price of cheese obtained by export to all markets in the previous year, i.e., to assume a one-year lag. The producer is thus thought to determine the proportion of total milk converted into butter after considering the relative prices of butter and cheese in the year just ended. This relation might be introduced in any of several ways—as the ratio for either country or as a simple or weighted average of the prices in both. Owing to the greater importance of cheese exports over the period as a whole for New Zealand it was decided to take the ratio for that country. It is not likely, given the closeness of the movements, that significantly differing figures would have been obtained if any of the other methods had been used.

The Australian-New Zealand supply equation therefore comprised three variates: the price obtained in the United Kingdom, total milk output, and the ratio of the price of butter to the price of cheese in the previous year. The signs of the first two would be expected to be positive as before. Given the form of the butter-cheese ratio, an increase in the price of butter would raise the ratio, and this would raise the proportion of milk processed into butter and so raise the supply of butter. Hence the sign should be positive if the relationship holds.

For model IVa the equations are:—

Demand for Danish butter:

$$y_1 = \alpha_1 y_3 + \alpha_2 y_4 + \alpha_3 z_1 + \alpha_4 z_2 + \alpha_5 z_3 + \varepsilon_{37} \quad \text{(Equation 37)}$$

Demand for Australian-New Zealand butter:

$$y_2 = \beta_1 y_3 + \beta_2 y_4 + \beta_3 z_1 + \beta_4 z_2 + \beta_5 z_3 + \varepsilon_{41} \quad \text{(Equation 41)}$$

Supply of Danish butter:

$$y_1 = \gamma_1 y_3 + \gamma_2 z_5 + \gamma_3 z_6 + \gamma_4 z_7 - \gamma_1 z_4 + \varepsilon_{45} \quad \text{(Equation 45)}$$

Supply of Australian-New Zealand butter:

$$y_2 = \delta_1 y_4 + \delta_2 z_8 + \delta_3 z_9 + \varepsilon_{49} \quad \text{(Equation 49)}$$

For the meaning of the terms and the values and signs of the coefficients see Table 8.

Taking the demand equations first, it is clear that only one pair of price elasticities have the expected sign. In the Australian-New Zealand equation not only are the signs reversed, but the magnitudes are far above those of the Danish equation. In both the income elasticity is shown to be negative, and the coefficient with respect to the United Kingdom price of margarine is also negative. In the Danish equation the coefficient with respect to the price of all other goods is negative too, but it has the expected sign in the Australian-New Zealand equation. The latter is the only coefficient in the Australian-New Zealand equation having the expected sign. It will be noted that the order of magnitude of the coefficients in the Danish equation is much nearer the expected level than those of the other equation.

Turning to the supply equations, we find the position is very largely the same. The sign of the coefficient with respect to the commodity's own price has the expected positive sign in the Danish equation but a negative sign in the other. Similarly milk output has the expected sign in the Danish equation but a negative sign in the other. It is not possible to accept the positive sign of the coefficient with respect to conversion costs. The fourth variate, the retail price of vegetable margarine, has the expected negative sign. The magnitude of these coefficients seems quite reasonable. The third variate in the Australian-New Zealand equation, the butter-cheese ratio, has the expected sign.

There are peculiarities in both sets of results, but the Danish equations do not only show the expected sign more often, but also indicate a more likely degree of responsiveness than do the other set of coefficients.

Model IVb

The equations for model IVb are the same as in model IVa. The only difference is that the variates are expressed in model IVb in natural units instead of in logarithms.*

The elasticities are set out in Table 8.

It will be seen that both pairs of price elasticities now have the expected signs. Income elasticity is again negative in the Danish equation but has become positive in the other. The coefficient with respect to the price of other goods is negative in the Danish equation but positive in the other. The coefficient with respect to the price of margarine has the expected positive sign only in the second equation.

In the supply equations the elasticity of supply is again positive only in the Danish equation. Milk output shows a positive relation in both equations. Again the sign of the coefficient with respect to conversion costs cannot be accepted, but the coefficient with respect to the retail price of vegetable margarine has the expected negative sign. The butter-cheese ratio now has the wrong sign.

The only notable change in signs due to the change in the form of the equations is in the price elasticities for Australia-New Zealand. But it might also be noted that for many coefficients the magnitudes are rather more plausible in model IVb than in model IVa.

Models IVc and IVd

Although the principal variation between these two models and the previous pair is to be found in the supply function, it is well to treat the demand equations first. The demand equations of model IVd require no further discussion for they are exactly the same as those used in model IVa.

Once before we introduced lagged prices in the demand equations (*vide* models Ic, Id, IIc and IId), but the introduction was not wholly satisfactory because either or both of two effects could be ascribed to these prices and expectations as to sign are opposite for the two effects. The problem is simpler here because there is no effect via changes in proportions of stocks to confuse the upshot. Here we have a commodity bought and used by the final consumer. It is a very reasonable hypothesis, derived from both introspection and observation, that consumers do not, when a change in relative prices occurs, immediately rearrange their purchases in the manner described in accounts of the theory of value. If it is the price of the alternative quality that has changed it might take some time before they are fully aware of the relative movement of the two

* The equations before the coefficients are converted to elasticities are:—

Demand for Danish butter:

$$y_1 = -2.73y_3 + 2.90y_4 - 0.016z_1 - 0.051z_2 - 0.113z_3 + e_{38}. \quad (\text{Equation 38})$$

Demand for Australian-New Zealand butter:

$$y_2 = -9.79y_3 - 12.40y_4 + 0.039z_1 + 0.075z_2 + 1.807z_3 + e_{42}. \quad (\text{Equation 42})$$

Supply of Danish butter:

$$y_1 = +0.18y_3 + 0.0013z_5 + 0.0012z_6 - 0.105z_7 - 0.18z_4 + e_{46}. \quad (\text{Equation 46})$$

Supply of Australian-New Zealand butter:

$$y_2 = -0.38y_4 + 0.0049z_8 - 0.93z_9 + e_{50}. \quad (\text{Equation 50})$$

As these are not the coefficients of equations in a logarithmic form the required elasticities have to be calculated.

1951]

prices. Even when they become aware of any such relative change it is unlikely that they will fully adjust their purchases at once. It is reasonable to imagine in many cases where commodities differ in flavour, as did the two varieties of butter investigated in model IV, that the response would be somewhat tardy and rather piecemeal. There is thus a case for introducing past prices as a determinant of current purchases alongside the other variates. As our data are annual it is necessary to introduce a lag of at least one year. In the case of a consumption good which is not durable and is being bought regularly at short intervals it seems unlikely that the main response would not come within the year. We have, therefore, added the average values for the previous year, beginning unfortunately but necessarily with 1919.

The expectation is that with respect to the commodity's own price in the previous year current demand would move negatively—a low price the previous year leading to a larger current demand and a high price the previous year leading to a smaller current demand—while with respect to the previous year's price of the commodity from the alternative source current demand would move positively. If Danish butter was relatively expensive last year there would be a greater demand for Australian-New Zealand butter this year than would otherwise have been the case, while if it had been relatively cheap current demand for Australian-New Zealand butter would be less than otherwise it might have been.

The introduction of lagged prices in model IVc means that two more variables are added to an already heavily loaded system. One economy was possible. Instead of introducing the cost of living index as a separate variate it might be used directly to deflate money income and the three prices. This was done. It is equivalent to assuming there is no "money illusion". Thus in the demand equation of model IVc we have the two deflated prices for both the current and the previous year, real income and the deflated retail price of margarine.

In models IVa and IVb we assumed that total milk produced was a wholly predetermined quantity. But the analogy between an annual crop, such as wheat, and a continuing though seasonally fluctuating supply such as milk, is limited. Whereas it is clear that once the sowing season has passed the farmer can do little indeed to add to output, this cannot be assumed to be so fully the case with a continuing output. Within limits output can be raised or lowered in the light of prevailing market possibilities. Such being the case total output could not be regarded as wholly predetermined, and the variate for total milk produced was consequently dropped from the supply equations in models IVc and IVd.

Two further variations were introduced into these two models. We have already discussed the possibility that demand would react to a relative change of prices over a period of time, and therefore current demand would be in part related to what prices were at some period in the immediate past. A similar lag in adjustment can be envisaged on the supply side. An improvement in prices in one export market is unlikely to be instantaneously answered by a diversion of supplies from other outlets to that market. Some immediate diversion there might be, but the full reaction would appear over some period of time. Without knowing the type of marketing organization and system of contracting it is difficult to estimate the average length of this adjustment period. Following previous practice, which in this model is in any case unavoidable because of the war years 1914-18, we have introduced a lag of one year in the supply equations. If the price of Danish butter in the United Kingdom was high a year before, current supply will be higher than would otherwise be the case; if the price was low current supply would be lower. That is, we would expect a positive relation.

The second variation is confined to the Australian-New Zealand supply equation. It will be remembered that in models IVa and IVb supply was represented by the commodity's own price, total milk produced and the ratio between the average export price of butter and the average export price of cheese in the previous year. Now we have decided to drop total milk produced. But there is another influence which might be included. Changes in the prices of butter and cheese very sharply affected the incomes of the producers owing to their specialization on these products. So instead of contracting their production in response to a fall in prices they usually increased it in the hope of maintaining their incomes by larger sales. This might be shown by reference to New Zealand during the years of the 1929-34 depression. In 1929 their butter fetched 183 shillings per cwt. in the British market, but it fetched only 97 shillings in 1932, 81 shillings in 1933, and 66 shillings in 1934. In 1928-9 they produced just under 100,000 tons of butter, while in 1933-4 they produced over 160,000 tons of butter. Costs were not substantially

raised, as dairying was very largely a family activity using relatively little paid labour. This suggests that the level of producers' real income should be brought into the supply equation as a third variate. Consequently such a series was estimated for farmers in Australia-New Zealand, allowance being made for subsidies received. The method of estimation is described in a note in the appendices. We should expect to find a negative sign for the coefficient of this variate if the reaction held throughout the period. It will be realized, however, that producers should not be assumed to want constant real incomes. While they may try to maintain income as far as possible through increasing output when prices fall, they may be equally anxious to raise their real incomes when the price of their own products rise. The coefficient for the period as a whole might well therefore turn out to have a positive value.

Model IVc

For this model the equations are:—

Demand for Danish butter:

$$y_1 = \alpha_1 y_3 + \alpha_2 y_4 + \alpha_3 z_1 + \alpha_4 z_3 + \alpha_5 z_{10} + \alpha_6 z_{11} - (\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4) z_2 + \varepsilon_{39}. \quad (\text{Equation 39})$$

Demand for Australian-New Zealand butter:

$$y_2 = \beta_1 y_3 + \beta_2 y_4 + \beta_3 z_1 + \beta_4 z_3 + \beta_5 z_{10} + \beta_6 z_{11} - (\beta_1 + \beta_2 + \beta_3 + \beta_4) z_2 + \varepsilon_{43}. \quad (\text{Equation 43})$$

Supply of Danish butter:

$$y_1 = \gamma_1 y_3 + \gamma_2 z_6 + \gamma_3 z_7 - \gamma_1 z_4 + \varepsilon_{47}. \quad (\text{Equation 47})$$

Supply of Australian-New Zealand butter:

$$y_2 = \delta_1 y_4 + \delta_2 z_9 + \delta_3 z_{12} + \varepsilon_{51}. \quad (\text{Equation 51})$$

For the meaning of the terms and the values and signs of the coefficients see Table 8.

This time it is the Australian-New Zealand pair of price elasticities that have the expected signs and the Danish pair which do not. In both cases the magnitude is much greater than would be expected. The remaining four signs are the same. Each shows a negative income elasticity, a positive coefficient with respect to the price of margarine, and for the lagged prices of both qualities a negative relation is shown. All that can be said of this disappointing array of signs is that neither deflation of income nor the introduction of lagged prices (at least in the way introduced here) has been helpful.

When we turn to the supply equations we find the Danish supply coefficients have the expected signs despite the unsatisfactory nature of the demand coefficients. The elasticity of supply in the Australian-New Zealand equation is still negative instead of positive. The coefficient with respect to the deflated value of agricultural production is positive. The butter-cheese ratio is, however, positive as in model IVa. Let us see the results of model IVd in comparison with these.

Model IVd

For model IVd the equations are:—

Demand for Danish butter:

$$y_1 = \alpha_1 y_3 + \alpha_2 y_4 + \alpha_3 z_1 + \alpha_4 z_2 + \alpha_5 z_3 + \varepsilon_{40}. \quad (\text{Equation 40})$$

Demand for Australian-New Zealand butter:

$$y_2 = \beta_1 y_3 + \beta_2 y_4 + \beta_3 z_1 + \beta_4 z_2 + \beta_5 z_3 + \varepsilon_{44}. \quad (\text{Equation 44})$$

Supply of Danish butter:

$$y_1 = \gamma_1 y_3 + \gamma_2 z_6 + \gamma_3 z_7 - \gamma_1 z_4 + \gamma_4 z_{10} + \varepsilon_{48}. \quad (\text{Equation 48})$$

Supply of Australian-New Zealand butter:

$$y_2 = \delta_1 y_4 + \delta_2 z_9 + \delta_3 z_{12} + \delta_4 z_{11} + \varepsilon_{52}. \quad (\text{Equation 52})$$

For the meaning of the terms and the values and signs of the coefficients see Table 8.

1951]

Here both pairs of price elasticities have the wrong sign, as has income. The coefficient with respect to the price of margarine in the United Kingdom has the expected sign in the Danish equation only. The coefficient with respect to other prices is negative and too large in the Danish equation. The introduction of lagged prices in the supply equations has raised the size of the coefficients in the Danish equation, but the sign of the coefficient with respect to the lagged price has the wrong sign in that equation. It will be noted that the lagged price in the Australian-New Zealand equation has had the expected effect on the size of the coefficient of the other lagged price relation, the butter-cheese ratio, namely, to reduce it. At the same time we have the persistent negative sign for the price elasticity, and again have a positive relation between farmers' real income and output.

12. Concluding Remarks on the Models

We have noted *en passant* the extent to which the signs and magnitudes (or relative magnitudes) of the various coefficients conformed with whatever *a priori* expectations we had about them. This is as much as the economist as such can do to decide whether the models do or do not produce sensible results. Two broad impressions emerge. In the first place, it will be seen that only rarely do the coefficients in any equation all show the expected sign or magnitude, and from one case to the next they are not consistently of the same sign. In the second place, it will be noted that we have, taking all the models together, rather more price coefficients of the right sign than of the wrong sign. However, in cases where there is a very high substitution effect between two commodities we should expect a very high correlation of their prices. In models I, II and IV we find a correlation between the two average value series of over 0.98. In model Ia the coefficients of wheat output-plus-stocks in the regressions of average values on the predetermined variables are for Australia-New Zealand -0.134 and -0.050, and for Argentina -0.123 and -0.054. As the demand equations depend, as mentioned earlier, on a linear combination of these balancing the coefficients in the regression equation for quantity, it is clear that even small errors in the regression coefficients would have considerable effect on the coefficients of the average values in the demand equations. Thus if the models were working satisfactorily in other respects we should get coefficients of the average values which were distributed with a very large sampling variance about their true values. We should, in consequence, obtain more often than not the right sign. In model III the correlation between the two average values is not so high (0.83) and there is less reason for a breakdown on this account.

Three statistical tests were applied to the results obtained. One test is to calculate von Neumann's ratio $\frac{s^2_{\epsilon}}{s^2}$ for the residuals from the calculated equations. This provides a very rough test of the assumption that the error terms are randomly distributed. The results of the calculation are shown in Tables 5 to 8. It is seen that there is no very striking evidence of lack of randomness in so far as it is brought out by this ratio. This is especially true of the demand equations.

A second test is to obtain a measure of the goodness of fit of the equations to the observations. It does not appear appropriate to calculate a "multiple correlation coefficient" when the equations have been obtained in the manner described. It may, nevertheless, be useful to find the ratio of the variance of the residual to the variance of the "explained" variate.* This ratio would equal $1 - R^2$ for fitting by least squares. The ratio $\frac{s^2_{\epsilon}}{s^2_y}$ is shown for each equation in Tables 5 to 8. The immediately striking result is that the variance of the residual is greater in several instances than the variance of the "explained" variate. The way in which this arises can be seen by looking again at the just identified case, for instance the demand equations in models I and II. The residual is a linear combination of the residuals in the regression equations of the

* It must be noted that the "explained" variate is the one which is to be explained from the economic point of view. From the statistical approach there is, of course, no reason for attaching the error term to one of the jointly determined variates rather than to another. The comparison made indicates whether or not the structural equations have any value to the economist.

jointly determined variates on all the predetermined variates. If the coefficients of the two average value variates is high and if the residual in the regression equations for these variates has a large variance, i.e., roughly speaking, if the multiple correlation coefficient is low, then the residual in the structural equation can become very large indeed despite the intercorrelations between the residuals of the average value variates. Thus to get low residuals in the structural equations we must have very high multiple correlations in the reduced form equations. If we

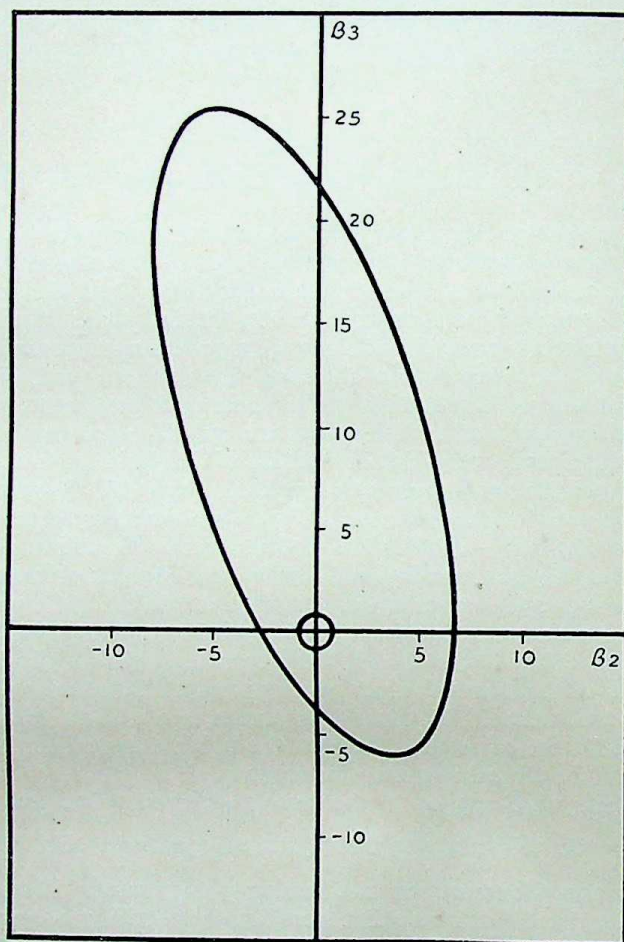


DIAGRAM 1.—Confidence Region for the Price Coefficients of the Swedish Demand Equation for United Kingdom Steel-Plate (Model III)

are dealing with a case where the coefficients of the jointly determined variates can be large, as in many of our results, the multiple correlations may hardly be allowed to differ from 1.

In view of the nature of some of our predetermined variates it is doubtful whether we are justified in using confidence regions suggested by Anderson and Rubin (1949) on the assumption that all predetermined variates are exogenous. Nevertheless, it might be of some interest to see whether such confidence regions would suggest the lack of reliability or otherwise of the price coefficients. We have studied the confidence regions only for these coefficients in the demand equations using, in fact, the form of the regions given by Anderson (1950). This form is based on the fact that if the coefficients of the jointly determined variates are known, the ratio of two quadratic forms in these coefficients will have an F -distribution. The confidence region taken for the coefficients is that region which gives a ratio below the 5 per cent. point for F .

The confidence region for the price coefficients of the Swedish demand equation for United

1951]

Kingdom steel-plate as given in model III is shown in Diagram I. The region consists of all points inside the ellipse shown. As can be seen, the region is very large, and indicates that we can attach very little reliance to the results. From an economic point of view, as noted earlier, the second demand equation in model III is more acceptable than the first. But the ellipse for this equation (Diagram 2), though smaller than that for the first equation, is still quite large.

A further example is that of the demand equation for Danish butter in model IVa, which is shown in Diagram 3. Here the confidence region consists of a hyperbola. From the direction of the axes we can suspect the influence of the high correlation between the average value series. In the demand equation for Australian-New Zealand wheat in model Ia the region comes out as the area *outside* an ellipse.

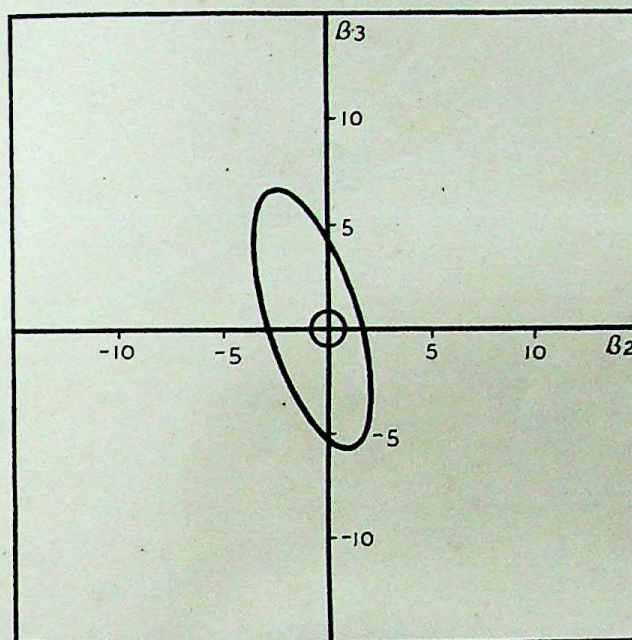


DIAGRAM 2.—Confidence Region for the Price Coefficients of the Swedish Demand Equation for German Steel-Plate (Model III)

Thus the confidence regions are either very large or even infinite.

It is evident that the price elasticities obtained are not very satisfactory. Several of the other coefficients are not acceptable from the economic point of view, and though the crudeness of the models makes a strict economic interpretation of these coefficients somewhat dubious, we are compelled to conclude that, taken as a whole, the method has failed. This does not mean, of course, that our calculations condemn the simultaneous equation approach in all applications to economic time-series, any more than our earlier results condemn least-squares regression when the assumptions underlying it are satisfied. Neither method seems to be appropriate in our field of interest. For even when we take commodities for which it is comparatively easy to construct economically sensible models the method breaks down.

13. General Conclusions

We have examined the use of different statistical methods in the study of the influence of price in international trade. We found on theoretical grounds that a simple regression of relative quantities on relative prices was unlikely to give us the sort of measure we wanted. When we examined the method in practice we found that several of our coefficients had the wrong sign, and that in some of the other cases the correlation was low and not significant. We then considered the introduction of the additional variates, income and time, into our regression analysis. We

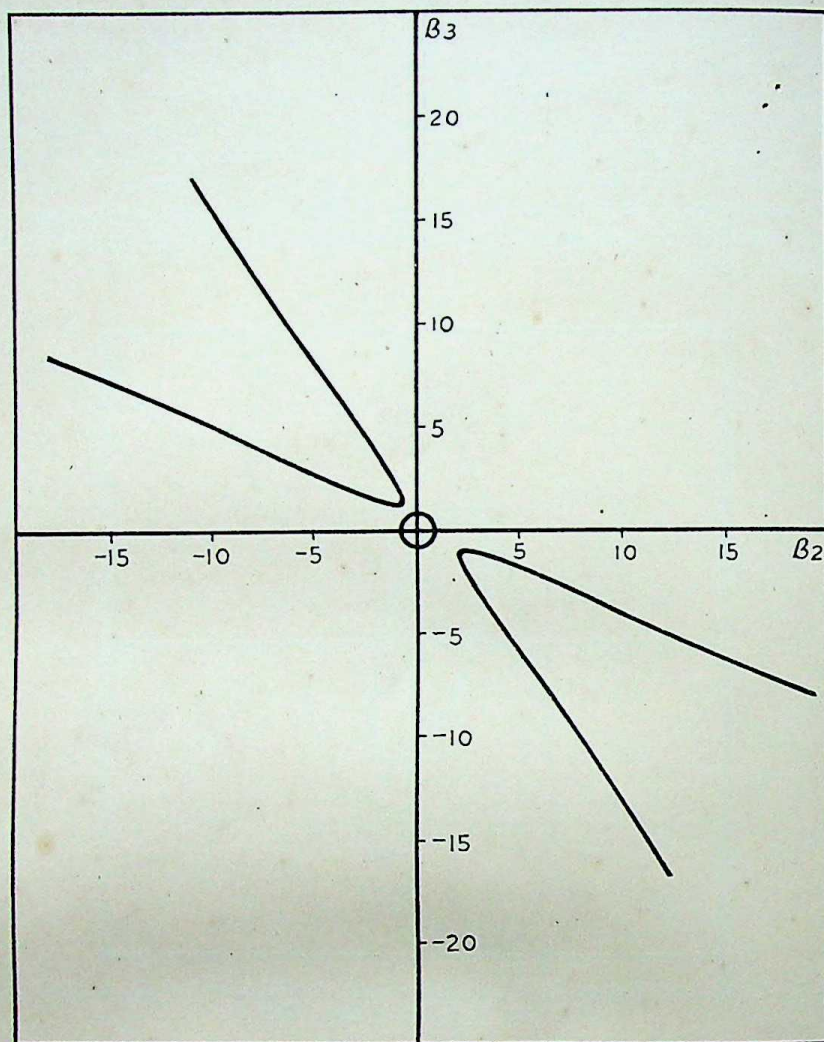


DIAGRAM 3.—Confidence Region for the Price Coefficients of the United Kingdom demand equation for Danish Butter (Model IVa)

found in the case of income that we still obtained several coefficients of relative prices of the wrong sign. The same applied in the cases where we allowed for trend. Next we followed up the suggestion that we might eliminate difficulties due to autocorrelation in the error terms by calculating regressions of first differences. Although our results suggest an improvement in the randomness of the residuals, once again a large number of our coefficients were of the wrong sign. Thus none of these well-known methods gave results which were acceptable from the economic point of view. As mentioned previously, there are several reasons why this could have happened.

Finally we adopted experimentally the simultaneous equation approach developed mainly by the Cowles Commission. In view of the fact that this method is comparatively new we discussed at some length the problems involved and the interpretation of the results. Once again the results were not particularly satisfactory from the economic point of view. We pointed out that there were several reasons why the results obtained might not be valid in the application of the method to the kind of international trade statistics that we have used. We found that the statistical tests associated with this method, while not strictly applicable to our cases, did indicate that the coefficients for average values were very unreliable.

TABLE 6

Model II: *Wheat (Australia-New Zealand and the Rest of the World, 1890-1914, omitting 1896, 1897, 1898 and 1903)*

Equation Number	Equation	Model	Elasticity with Respect to—										$s^2/\varepsilon^2 y$	δ^2/s^2
			y_3	y_4	z_1	z_2	z_3	z_4	z_5	z_6	z_7			
17	Demand for Australian-New Zealand wheat (y_1)	IIa	-25.54	21.21	-2.96	19.88	—	—	—	—	—	1.19	1.29	
18		IIb	-23.39	18.35	-4.91	25.74	—	—	—	—	—	1.13	1.18	
19		IIc	-7.52	3.12	8.19	-8.48	3.45	1.27	—	-0.74	—	0.42	2.62	
20		IId	-11.39	6.16	4.61	0.34	1.54	2.64	-0.86	—	—	0.54	2.17	
21	Demand for rest of the world wheat (y_2)	IIa	1.74	-2.73	0.28	2.93	—	—	—	—	—	1.08	1.40	
22		IIb	2.64	-3.93	-0.53	5.39	—	—	-0.31	—	—	1.18	1.37	
23		IIc	6.13	-7.13	2.67	-3.27	0.28	0.90	—	—	—	1.52	2.19	
24		IId	4.71	-6.01	1.35	-0.04	-0.42	1.40	-0.31	—	—	1.34	2.10	
25	Supply of Australian-New Zealand wheat (y_1)	IIa	-0.98	—	—	—	—	—	—	1.64	—	0.14	1.84	
26		IIb	-1.08	—	—	—	—	—	—	1.66	—	0.14	1.82	
27		IIc	-1.24	—	—	—	—	—	—	1.67	—	0.13	1.90	
28		IId	-1.17	—	—	—	—	—	—	1.66	—	0.13	1.91	
29	Supply of rest of the world wheat (y_2)	IIa	—	0.04	—	—	—	—	—	—	0.52	0.42	1.72	
30		IIb	—	0.01	—	—	—	—	—	—	0.53	0.42	1.71	
31		IIc	—	-0.03	—	—	—	—	—	—	0.52	0.39	1.77	
32		IId	—	-0.02	—	—	—	—	—	—	0.52	0.39	1.78	

Where: y_1 = imports of Australian-New Zealand wheat into the United Kingdom in lbs. per head of population.

y_2 = rest of the world

y_3 = average value in shillings per cwt. of wheat imported into the United Kingdom from Australia-New Zealand.

y_4 = United Kingdom net national income at factor cost in current prices per head of population.

z_1 = index of the cost of living (1914 = 100).

z_2 = average value in shillings per cwt. of wheat imported into the United Kingdom from Australia-New Zealand in the previous year.

z_3 = stocks of wheat and flour in first hands in the United Kingdom at the beginning of January each year.

z_4 = wheat output and carry-over of Australia-New Zealand.

z_5 = Russia, the United States, Canada, Argentina and India.

z_6 = rest of the world

z_7 = rest of the world

All variables are in logarithms and are measured as deviations from their means. For series used see Appendices.

TABLE 7

Model III: *Steel-Plates (United Kingdom and Germany, 1920-1938, omitting 1923)*

Equation Number	Equation	Elasticity with Respect to—										$s^2/\epsilon/s^2 y$	$\delta^2/s^2 y$
		y_3	y_4	z_1	z_2	z_3	z_4	z_5	z_6	z_7	z_8		
33	Demand for United Kingdom steel-plate (y_1)	-3.35	11.03	-15.47	0.40	2.94	—	—	—	—	—	0.57	2.57
34	Demand for German steel- plate (y_2)	0.28	-3.79	-3.29	6.06	1.41	—	—	—	—	—	0.40	2.24
35	Supply of United Kingdom steel-plate (y_1)	-1.51	—	—	—	—	-0.74	1.95	1.51	—	—	0.73	1.50
36	Supply of German steel-plate (y_2)	—	0.27	—	—	—	—	—	—	0.17	0.34	-0.27	1.20

Where: y_1 = imports of Article 735A from the United Kingdom into Sweden in grammes per head of the population.

y_2 = " " " " Germany

y_3 = average value in kroner per 10 kilograms of Article 735A imported from the United Kingdom into Sweden, including a duty of 0.45 kroner.

y_4 = average value in kroner per 10 kilograms of Article 735A imported from Germany into Sweden, including a duty of 0.45 kroner.

z_1 = Swedish net national income at factor cost in current prices per head of population.

z_2 = index of prices of industrial raw materials in Sweden (1913 = 100).

z_3 = output of sheet of a thickness of less than 3 millimetres in Sweden.

z_4 = index of productivity in the United Kingdom iron and steel industry.

z_5 = " " " " wage rates in the United Kingdom adjusted for exchange rate variations.

z_6 = average value in kroner per 10 kilograms of Article 735A imported from the United Kingdom with duty added as a percentage of average value without duty.

z_7 = index of productivity in the German iron and steel industry.

z_8 = " " " " wage rates in Germany adjusted for exchange rate variations.

z_9 = average value in kroner per 10 kilograms of Article 735A imported from Germany with duty added as a percentage of average value without duty.

All variables are in logarithms and are measured as deviations from their means. For series used see Appendices.

TABLE 8

Model IV: *Butter (Denmark and Australia-New Zealand, 1920-1936)*

Equation Number	Equation	Model	Elasticity with Respect to—												$s^2 e^{1/2} y$	δ_j/s_2
			y_3	y_4	z_1	z_2	z_3	z_4	z_5	z_6	z_7	z_8	z_9	z_{10}	z_{11}	z_{12}
37	Demand for Danish butter (O_1)	IVa	-5.41	4.71	-0.81	-0.74	-0.66	—	—	—	—	—	—	—	—	—
38		IVb	-4.74	4.51	-0.68	-1.79	-0.17	—	—	—	—	—	—	—	—	—
39		IVc	41.97	-25.87	-9.18	-21.59	14.67	—	—	—	—	—	—	-6.75	-6.46	—
40		IVd	2.78	-1.98	-0.41	-3.42	0.84	—	—	—	—	—	—	—	—	—
41	Demand for Australian-New Zealand butter (O_2)	IVa	-79.89	63.54	-5.88	28.49	-15.05	—	—	—	—	—	—	—	—	—
42		IVb	12.80	-14.11	1.24	1.93	2.05	—	—	—	—	—	—	—	—	—
43		IVc	81.07	-49.57	-20.15	-39.81	28.46	—	—	—	—	—	—	-14.59	-12.75	—
44		IVd	-28.53	22.87	-2.16	8.45	-5.96	—	—	—	—	—	—	—	—	—
45	Supply of Danish butter (O_1)	IVa	0.19	—	—	—	—	-0.19	1.42	0.29	-0.52	—	—	—	—	—
46		IVb	0.31	—	—	—	—	-0.31	1.22	0.03	-0.41	—	—	—	—	—
47		IVc	0.76	—	—	—	—	-0.76	—	-1.63	-0.08	—	—	—	—	—
48		IVd	7.85	—	—	—	—	-7.85	—	-7.65	3.14	—	—	-8.76	—	—
49	Supply of Australian-New Zealand butter (O_2)	IVa	—	-12.05	—	—	—	—	—	—	—	-14.48	4.58	—	—	—
50		IVb	—	-0.43	—	—	—	—	—	—	—	1.13	-0.32	—	—	—
51		IVc	—	-1.46	—	—	—	—	—	—	—	—	1.22	—	—	—
52		IVd	—	-1.77	—	—	—	—	—	—	—	—	0.51	—	—	—

Where: y_1 = imports of butter into the United Kingdom from Denmark in lbs. per head of population. y_2 = imports of butter into the United Kingdom from Denmark in lbs. per head of population. y_3 = average value in £ per cwt. of butter imported into the United Kingdom from Denmark. y_4 = average value in £ per cwt. of butter imported into the United Kingdom from Denmark. z_1 = index of United Kingdom net national income at factor cost in current prices per head of population (1900 = 100). z_2 = United Kingdom index of the cost of living (1914 = 100). z_3 = average retail price of good quality margarine in the United Kingdom in pence per lb. z_4 = average value of Danish butter including duty as percentage of the average value of Danish butter without duty. z_5 = total milk produced in Denmark in million kilograms. z_6 = conversion cost in Denmark, deflated by the sterling-kroner rate of exchange, in pence per thousand kilograms of fresh milk. z_7 = retail price of vegetable margarine in Denmark, deflated by the sterling-kroner rate of exchange, in pence per kilogram. z_8 = total milk produced in Australia-New Zealand in million gallons. z_9 = ratio of the average export price of butter to the average export price of cheese in the previous year for New Zealand. z_{10} = ratio of the average import price of Danish butter including duty in the previous year deflated by the cost of living index of that year. z_{11} = average value of imports of Danish butter in the previous year deflated by the cost of living index of that year. z_{12} = average value of imports of Australian-New Zealand agricultural production deflated by cost of living indices. z_{13} = net value of Australian and New Zealand agricultural production deflated by cost of living indices.

All variables are in logarithms and are measured as deviations from their means. For series used see Appendices.

1951]

In view of our lack of success in measuring the influence of price in international trade and in view of the difficulty of obtaining data which would be more suitable for such measurement, we conclude that all calculations in this field must be accepted with the utmost reserve.

14. Acknowledgements

Our principal debt of gratitude is undoubtedly that owed to Professor J. E. Meade. Professor Meade not only suggested the project in the first place, but for long actively directed its execution and has maintained a keen interest in its later development. In expressing our very sincere thanks to him we must add that he should not be assumed necessarily to agree either with the detailed form of the models or with the views and findings set out in this paper.

We are grateful also to Professors R. G. D. Allen and T. Koopmans for helpful criticisms of our models. Several colleagues at the London School of Economics and others in government departments and foreign embassies have helped us with advice at various points in our work. We should like to acknowledge their help with gratitude and also that of the staffs of many libraries, particularly those of the London School of Economics and the Royal Statistical Society, who lightened the burden of collecting data.

Finally we should like to thank the Committee of the Economic Research Division of the London School of Economics for the grants of funds to finance the heavy and expensive process of computing. Without this help the project could not have proceeded.

15. References

- ALLEN, R. G. D. (1934), *Economica*, 1, 196.
 ANDERSON, T. W. (1950), "Estimation of the parameters of a single equation by the limited information maximum-likelihood method", in *Statistical Inference in Dynamic Models*.
 ———, and RUBIN, H. (1949), *Ann. Math. Statist.*, 20, 46.
 CHANG, T. C. (1948), *Review of Economics and Statistics*, 30, 106.
 COCHRANE, D., and ORCUTT, G. H. (1949), *Journal of the American Statistical Association*, 44, 32.
 DURBIN, J., and WATSON, G. S. (1951), *Biometrika*, 37, 409.
 FRISCH, R. (1934), *Statistical Confluence Analysis by means of Complete Regression Systems*. Oslo.
 GIRSHICK, M. A., and HAAVELMO, T. (1947), *Econometrica*, 15, 79.
 KOOPMANS, T. C., RUBIN, H., and LEIPK, R. B. (1950), *Statistical Inference in Dynamic Economic Models*, p. 53. New York: Wiley.
 KUBINSKI, Z. (1950), *Yorkshire Bulletin of Economic and Social Research*, 2, 17.
 POLAK, J. J. (1950), *Review of Economics and Statistics*, 32, 16.
 SCHULTZ, H. (1938), *The Theory and Measurement of Demand*. The University of Chicago Press.
 TINBERGEN, J. (1946), *Review of Economic Statistics*, 28, 109.

16. Appendices

(1) Data for Regression Analysis

(i) y_1 : Logarithm of the ratio of quantities imported as given in the Trade Returns of importing countries.

(ii) x_1 : Logarithm of the ratio of the corresponding average values calculated from the Trade Returns.

(iii) μ : Logarithm of real national income as follows:

(a) United Kingdom—index of net national income at factor cost at 1900 prices from Prest, *Economic Journal*, Vol. LVIII, pp. 58–59.

(b) United States—for cement, gross national product at 1929 prices from S. Kuznets, *National Product since 1869*, pp. 52 and 56. For others, net national product at 1929 prices from *ibid*.

(c) Australia—available real income at 1923–27 prices from Clark and Crawford, *The National Income of Australia*, pp. 64–65.

(d) Sweden—an estimated series of real national income at factor cost obtained as follows: In Table 306 of the *Statistik årsbok för Sverige* for 1950 there is a series (given as Alternative III) for net national income at market price in current values from 1923. From these figures were deducted the total for each year of receipts from customs, excise, automobile and building taxes to obtain an estimate at factor cost. The estimates for 1920–22 were obtained by taking the ratio of the figures given under Alternative III to the figures given under Alternative II (which included estimates for depreciation of con-

sumers' durable goods and net output in building) for 1923, and taking the same proportion of the figures given under Alternative II for the years 1920–22. The complete series for 1920–38 was then deflated by using the "indice du coût de la vie; ensemble; avec impôts et allocations sociales" (*ibid.*, Table 176).

(2) Data for the Models

As stated in the text in all cases logarithms were used except in Model IVb.

(i) Model I

y_1, y_2 : Quantities of wheat imported from Australia-New Zealand and Argentina respectively, as given in the Trade Returns, divided by total population (from *Statistical Abstract*).

y_3, y_4 : Corresponding average values calculated from the Trade Returns.

z_1 : United Kingdom net national income at factor cost in current prices per head of the population (Prent, *Economic Journal*, Vol. LVIII, pp. 58–59).

z_2 : Index of the cost of living in the United Kingdom (1914 = 100) (A. L. Bowley *Wages and Prices in the United Kingdom since 1860*).

z_3, z_4 : Average values for Australia-New Zealand and Argentina respectively lagged one year.

z_5 : Stocks of wheat and flour in first hands in the United Kingdom in quarters of 480 lb. from J. E. Beerbohm's *Evening Corn Trade List*, January issues, 1890–1914.

z_6, z_7 : Available wheat for the year from Australia-New Zealand and Argentina respectively. The series was obtained by combining estimated production for the year and estimated stocks at the beginning of the year. Output figures were obtained from *World Wheat Crops, 1885–1932* (Wheat Studies of the Food Research Institute, Stanford University, Vol. IX, No. 7, April, 1933). As in the southern hemisphere crops are harvested near the end of one calendar year and at the beginning of the next, production of one year has to be taken in conjunction with purchases of the following calendar year. This adjustment was made for the three sources in model I.

Carry-over figures were obtained from "*World*" *Wheat Stocks, 1890–1914 and 1922–39* (Wheat Studies of the Food Research Institute, Stanford University, Vol. XVI, No. 2, October, 1939). The figures for Australia and Argentina refer to August 1st, but by adding net shipments for the period August 1st–November 30th and August 1st–December 31st (obtained from G. Broomhall's *Corn Trade Year Books*), which had been deducted to obtain the August 1st totals, we were able to obtain stock figures for November 30th and December 31st respectively.

Data for Model I

Year	y_1	y_2	y_3	y_4	z_1	z_2	z_3	z_4	z_5	z_6	z_7
1890	0.9608	0.9244	0.9196	0.8737	1.5717	1.9494	0.9413	0.8602	6.2900	1.6852	1.4771
1891	0.7910	0.8169	0.9753	0.9505	1.5647	1.9494	0.9196	0.8737	6.2672	1.5800	1.5237
1892	0.7723	0.9586	0.9012	0.8673	1.5527	1.9542	0.9753	0.9505	6.4983	1.5927	1.5832
1893	0.8774	1.3092	0.8422	0.7924	1.5391	1.9494	0.9012	0.8673	6.5441	1.6459	1.7839
1894	1.0482	1.5334	0.7529	0.7097	1.5502	1.9294	0.8422	0.7924	6.5105	1.6535	1.9318
1895	0.9983	1.4634	0.7649	0.7414	1.5670	1.9191	0.7529	0.7097	6.2589	1.5489	1.8180
1899	1.0073	1.4453	0.8286	0.8045	1.6128	1.9345	—	—	6.0000	1.7594	2.0338
1900	1.0133	1.6533	0.8416	0.8175	1.6304	1.9590	0.8286	0.8045	6.3617	1.7277	2.0507
1901	1.2646	1.2889	0.8270	0.8201	1.6181	1.9542	0.8416	0.8175	6.3892	1.7793	1.8949
1902	1.0637	1.0128	0.8513	0.8316	1.6181	1.9542	0.8270	0.8201	6.3522	1.6772	1.8073
1904	1.4462	1.7017	0.8633	0.8460	1.6117	1.9638	—	—	6.3892	1.9253	2.1440
1905	1.4331	1.7329	0.8768	0.8530	1.6263	1.9638	0.8633	0.8460	6.4771	1.8647	2.2095
1906	1.3078	1.6457	0.8615	0.8429	1.6503	1.9685	0.8768	0.8530	6.3522	1.9012	2.1335
1907	1.3289	1.6996	0.8949	0.8661	1.6675	1.9777	0.8615	0.8429	6.4065	1.8888	2.2245
1908	1.1464	1.8562	0.9430	0.9178	1.6405	1.9685	0.8949	0.8661	6.4108	1.7543	2.3113
1909	1.4178	1.6533	0.9841	0.9670	1.6464	1.9731	0.9430	0.9178	6.2553	1.8877	2.2238
1910	1.5350	1.5275	0.9358	0.9111	1.6618	1.9823	0.9841	0.9670	6.2175	2.0103	2.1556
1911	1.5590	1.5130	0.9089	0.8910	1.6739	1.9868	0.9358	0.9111	6.4771	2.0457	2.2065
1912	1.4779	1.6162	0.9519	0.9180	1.6981	2.0000	0.9089	0.8910	6.3522	1.9307	2.2536
1913	1.3973	1.5096	0.9417	0.9200	1.7152	2.0086	0.9519	0.9180	6.3617	2.0086	2.3065
1914	1.4694	1.1494	0.9301	0.9001	1.6920	2.0000	0.9417	0.9200	6.3010	2.0664	2.0802

1951]

(ii) Model II

$y_1, y_3, z_1, z_2, z_3, z_5, z_6$: As in Model I.

y_2 : Quantity of wheat imported from the rest of the world, as given in the Trade Returns, divided by total population.

y_4 : Corresponding average value calculated from the Trade Returns.

z_4 : Average value for wheat imported from rest of the world in the previous year.

z_7 : Available wheat for the year was estimated as follows: Output of the five main wheat exporters (Russia, the United States, Canada, Argentina, and India) was obtained from *World Wheat Crops, 1915-1932*. In the case of Argentina it was necessary as before to take production of one calendar year in conjunction with purchases for the next, but the other suppliers, being northern hemisphere, did not require this adjustment. To these figures estimates of carry-over were added. For northern hemisphere countries it was satisfactory to take the August 1st figures obtained from *World Wheat Stocks, 1890-1914 and 1922-39*. We added the totals given for (a) Europe, ex-Russia; (b) Russia, surplus; (c) United States, grain in United States and in Canada; (d) Canadian grain in United States and Canada. To the total we added the December 31st total for Argentina as calculated for Model I, bringing it one year forward as previously. As we wanted a figure for availabilities abroad we deducted stocks in the British Isles.

Data for Model II

Note.— $y_1, y_3, z_1, z_2, z_3, z_5$ and z_6 as in Model I.

Year	y_2	y_4	z_4	z_7	Year	y_2	y_4	z_4	z_7
1890	2.2343	0.8904	0.8842	3.1587	1905	2.3566	0.8567	0.8432	3.3562
1891	2.2795	0.9474	0.8904	3.2333	1906	2.3421	0.8457	0.8567	3.3537
1892	2.2664	0.8837	0.9474	3.2393	1907	2.3570	0.8848	0.8457	3.3512
1893	2.2623	0.8075	0.8837	3.2751	1908	2.3371	0.9232	0.8848	3.3261
1894	2.2809	0.7267	0.8075	3.3030	1909	2.3424	0.9643	0.9232	3.3768
1895	2.3492	0.7404	0.7267	3.2887	1910	2.3581	0.9222	0.9643	3.3895
1899	2.2377	0.8248	—	3.3088	1911	2.3148	0.8976	0.9222	3.3644
1900	2.2469	0.8319	0.8248	3.2769	1912	2.3802	0.9253	0.8976	3.4180
1901	2.2293	0.8202	0.8319	3.3170	1913	2.3706	0.9154	0.9253	3.4700
1902	2.3006	0.8235	0.8202	3.3226	1914	2.3487	0.9355	0.9154	3.4350
1904	2.3610	0.8432	—	3.3568					

(iii) Model III

y_1, y_2 : Quantities of Article 735A imported into Sweden from the United Kingdom and Germany, as given in the Swedish Trade Returns, divided by total population (from *Statistik Arsbok för Sverige*).

y_3, y_4 : Corresponding average values calculated from the Trade Returns.

z_1 : Swedish net national income at factor cost in current prices deflated by cost of living index, as estimated for regression analysis, divided by total population.

z_2 : Index of industrial raw material prices (1913 = 100) from *Statistik Arsbok för Sverige*.

z_3 : Swedish production of sheet of less than 3 millimetre thickness in thousand metric tons, supplied by Swedish Commercial Attaché, London Embassy.

z_4 : Index of productivity in the United Kingdom iron and steel industry. This crude index was estimated in this way. Quantities produced in blast furnaces, smelting, rolling and tinplate (obtained from the Iron and Steel Federation) were combined on the basis of net output per ton produced as at 1935 (from census of production). This was divided by the product of two further series. One was that of insured employment in blast furnaces, steel smelting, iron puddling and tin-plate from Unemployment Insurance Statistics, 1924-38. The other was for shifts worked per man per week estimated from employers' returns for a section of the iron and steel trades (as given in *Ministry of Labour Gazette*). The figures were taken back to 1920 on the basis of employers' returns.

z_5 : United Kingdom index of average weekly wage-rates (1924 = 100) from *London and Cambridge Economic Service Bulletin* (Vol. XXVI, p. 31) adjusted for variations in the sterling-kroner exchange rate, taking 1924 as 100, from League of Nations, *International Statistical Year-Book*, 1926 and 1938.

z_7 : Index of productivity in the German iron and steel industry. This crude index was estimated on the basis of a similar coverage to that taken for the United Kingdom. Production and employment series were obtained partly from *Vierteljahrshefte für Statistik des Deutschen Reichs* and partly from *Wirtschaft und Statistik, Sonderhefte*. It was not found possible to adjust for hours or shifts worked.

z_8 : German index of wage-rates for skilled and unskilled workers from 1920–22 from C. Bresciani-Turroni, *The Economics of Inflation*. For later years from *Statistisches Jahrbuch für das Deutsche Reich*. These were brought to a common base and adjusted for exchange rate changes as set out in Bresciani-Turroni and League of Nations, *International Statistical Year-Book*, 1926 and 1938.

Data for Model III

Year	y_1	y_2	y_3	y_4	z_1	z_2	z_3	z_4	z_5	z_6	z_7	z_8	z_9
1920	2.0956	2.9211	0.8113	0.8059	3.2638	2.5900	1.3636	1.4392	2.1255	0.0333	1.6599	1.9138	0.0317
1921	1.1847	2.4547	0.7818	0.5505	3.0874	2.3118	1.1614	1.3722	2.1446	0.0335	1.7050	1.8470	0.0588
1922	2.1065	2.5822	0.4863	0.4076	3.0242	2.1849	1.2900	1.5338	2.0374	0.0690	1.7731	1.5966	0.0842
1924	2.6554	2.8549	0.4804	0.3967	3.0472	2.1673	1.5051	1.5877	2.0000	0.0700	1.8751	2.0314	0.0865
1925	2.3469	2.7825	0.4267	0.3838	3.0539	2.1703	1.5527	1.5949	1.9694	0.0801	1.9741	2.1126	0.0893
1926	1.5340	3.0103	0.4734	0.3553	3.0637	2.1399	1.6170	1.4582	1.9643	0.0713	2.0686	2.1430	0.0962
1927	1.2672	2.8442	0.3614	0.3579	3.0706	2.1335	1.5966	1.6300	1.9652	0.0947	2.1245	2.1717	0.0954
1928	1.7938	2.8282	0.4121	0.3385	3.0868	2.1461	1.6580	1.6332	1.9610	0.0831	2.0781	2.2041	0.1005
1929	1.1614	2.8175	0.5582	0.3336	3.1081	2.1239	1.7348	1.6661	1.9595	0.0577	2.0871	2.2227	0.1017
1930	0.6128	2.8871	0.5726	0.3212	3.1017	2.0792	1.6946	1.6731	1.9552	0.0556	2.0562	2.2305	0.1051
1931	1.0492	2.7942	0.3101	0.2686	3.0561	2.0334	1.7076	1.6451	1.9533	0.1081	2.0512	2.2127	0.1207
1932	1.9791	2.5516	0.3564	0.2403	3.0179	2.0212	1.6767	1.6704	1.9222	0.0958	1.9859	2.1399	0.1334
1933	2.0461	2.5529	0.3906	0.2494	3.0148	2.0128	1.7419	1.6843	1.9112	0.0879	1.9789	2.1265	0.1269
1934	1.8814	2.7762	0.4156	0.3172	3.0709	2.0414	1.8407	1.6929	1.9069	0.0824	2.0218	2.1258	0.1061
1935	1.8075	2.8646	0.4482	0.3060	3.0963	2.0531	1.8506	1.7132	1.9112	0.0758	2.0349	2.1258	0.1093
1936	2.2774	2.5675	0.4106	0.3135	3.1362	2.0719	1.8825	1.7396	1.9227	0.0835	2.0190	2.1258	0.1073
1937	0.4150	2.6991	0.8032	0.5039	3.1883	2.1614	1.9289	1.7384	1.9370	0.0319	1.9938	2.1265	0.0659
1938	1.0607	2.0842	0.7202	0.4618	3.2029	2.1106	1.9320	1.6939	1.9474	0.0389	2.0196	2.1265	0.0733

(iv) *Models IVa and IVb*.—In model IVa the series are in logarithms (as given below) while in Model IVb they are in natural units.

y_1, y_2 : Quantities of butter imported into the United Kingdom from Denmark and Australia-New Zealand respectively, as given in the Trade Returns, divided by total population as given in *Statistical Abstract*.

y_3, y_4 : Corresponding average values calculated from the Trade Returns.

z_1 : Index of net national income at factor cost at current prices (1900 = 100) per head of population, from Prest, *Economic Journal*, Vol. LVIII, pp. 58–59.

z_2 : United Kingdom cost of living index (1914 = 100), from *Ministry of Labour Gazette*.

z_3 : Average retail price of good quality margarine as collected for cost of living index, supplied by Ministry of Food, Statistical Department.

z_5 : Total milk produced in Denmark as given in *Thirty Years of Farm Accounts and Agricultural Economics in Denmark, 1917–1947* (Institute of Farm Management and Agricultural Economics, Copenhagen, 1949), p. 11.

z_6 : Conversion cost of processing milk into butter in Denmark as given in *Statistisk årbog 1937* (Table 64), which was adjusted for changes in the sterling-kroner rate of exchange as set out in League of Nations, *International Statistical Year-Book*, 1926 and 1938.

z_7 : Average retail price of vegetable margarine in Denmark as given in *Statistisk årbog 1937* (Table 112), which was also adjusted for variations in sterling-kroner rate of exchange.

1951]

z_8 : Total milk produced in Australia-New Zealand. This was obtained by adding to Australian milk production as given in the *Official Year-Book*, 1940 (p. 421), an estimate of New Zealand production obtained by converting estimated total butter-fat production (*Official Year-Book*, 1938, pp. 410 and 414), into milk at an average butter-fat content of 4.3 per cent.

z_9 : The butter-cheese ratio was obtained by dividing the average export value of butter by the average export value of cheese calculated from the New Zealand Trade Returns and bringing forward one year.

Data for Models IVa and IVb

Note.—The same series were used in Model IVb in natural units. The use of natural units enabled the tariff z_4 on Danish butter to remain as zero for the years 1920-1931 inclusive. For 1932, during the course of which the tariff was introduced, it averaged 0.545 (£ per cwt.) and thereafter was 0.750 (£ per cwt.).

Year	y_1	y_2	y_3	y_4	z_1	z_2	z_3	z_4	z_5	z_6	z_7	z_8	z_9
1920	0.2909	0.0799	1.1584	1.1507	2.4821	2.3962	1.1345	0	3.4150	2.3088	1.5198	2.9247	0.2544
1921	0.4727	0.5991	1.0816	1.0770	2.3756	2.3541	1.0000	0	3.5051	2.2989	1.4330	2.9878	0.2840
1922	0.5269	0.6818	0.9917	0.9047	2.3090	2.2625	0.8451	0	3.5315	2.1995	1.3224	3.0802	0.3171
1923	0.6643	0.6210	0.9598	0.9528	2.3051	2.2405	0.8293	0	3.5682	2.0885	1.2253	3.0766	0.3006
1924	0.6430	0.6373	1.0191	0.9528	2.3104	2.2430	0.8293	0	3.6021	2.0738	1.2529	3.0716	0.2534
1925	0.6150	0.7786	1.0136	0.9238	2.3152	2.2455	0.8848	0	3.6096	2.0878	1.3160	3.1453	0.3189
1926	0.6738	0.6739	0.9545	0.9063	2.3071	2.2355	0.9031	0	3.6335	2.1179	1.3118	3.1139	0.2904
1927	0.6923	0.6330	0.9467	0.9101	2.3300	2.2253	0.8797	0	3.6628	2.0755	1.2878	3.1249	0.2632
1928	0.6950	0.7117	0.9653	0.9117	2.3290	2.2201	0.8751	0	3.6767	2.0382	1.2765	3.1459	0.3021
1929	0.7328	0.7060	0.9520	0.9294	2.3304	2.2148	0.8751	0	3.7016	2.0338	1.2856	3.1709	0.2617
1930	0.7530	0.7882	0.8678	0.8248	2.3051	2.1987	0.8639	0	3.7312	2.0090	1.2529	3.1867	0.3075
1931	0.7778	0.9279	0.8022	0.7396	2.2700	2.1703	0.8573	0	3.7455	1.9877	1.2095	3.2191	0.2485
1932	0.7956	0.9783	0.7591	0.6946	2.2567	2.1584	0.8293	0.0433	3.7392	1.9269	1.1875	3.2562	0.2930
1933	0.7829	1.0051	0.6985	0.5999	2.2737	2.1461	0.7868	0.0707	3.7316	1.8663	1.1004	3.2958	0.2450
1934	0.7756	1.0595	0.6624	0.5527	2.2891	2.1492	0.7497	0.0774	3.7259	1.8859	1.1644	3.3236	0.2653
1935	0.7180	1.0550	0.7249	0.6232	2.3122	2.1553	0.7348	0.0661	3.7093	1.9063	1.0969	3.3240	0.2095
1936	0.7132	1.0282	0.7565	0.6730	2.3391	2.1673	0.7642	0.0612	3.7222	1.8420	1.0492	3.3214	0.2853

(v) Models IVc and IVd.—(All series are expressed in logarithms.)

$y_1, y_2, y_3, y_4, z_1, z_2, z_3, z_4, z_6, z_7, z_9$ are as in Model IVa.

z_{11}, z_{12} : Average values for the previous year.

z_{10} : Net value of Australian-New Zealand farm production. The series for New Zealand was obtained from the *Official Year-Book*, 1940, p. 918, for the three branches of farm production (agricultural, pastoral and dairying). These were added and then deflated by the use of the All Groups Index of Retail Prices (given in the *Official Year-Book*, 1944, p. 488) which was brought to a 1920 base. In the case of Australia a series for gross output in the three branches of farm production was obtained from the *Official Year-Books* for 1931 and 1939 (pp. 745 and 925 respectively). Each was reduced by the average percentage of this gross value represented over the period 1933-4 to 1937-8 by the sum of net values plus value of other materials used. To the figures thus obtained subsidies were added (*ibid.*) and the total for each branch was added. The total for each year was then deflated by using the Retail Price Index Numbers for All Items (as given in the *Official Year-Book*, 1942-43, p. 468) which was brought to a 1920 base. The totals for New Zealand and for Australia were then added for each year.

Data for Models IVc and IVd

Note.— $y_1, y_2, y_3, y_4, z_1, z_2, z_3, z_4, z_6, z_7, z_9$ as in Model IVa.

Year	z_{10}	z_{11}	z_{12}	Year	z_{10}	z_{11}	z_{12}
1920	2.3838	—1.1881	—1.2376	1929	2.4911	—1.2548	—1.3084
1921	2.4582	—1.2378	—1.2455	1930	2.4284	—1.2628	—1.2854
1922	2.3911	—1.2725	—1.2771	1931	2.3856	—1.3309	—1.3739
1923	2.4320	—1.2708	—1.3578	1932	2.3747	—1.3681	—1.4307
1924	2.4492	—1.2807	—1.2877	1933	2.3943	—1.3993	—1.4638
1925	2.5189	—1.2239	—1.2902	1934	2.4670	—1.4476	—1.5462
1926	2.4664	—1.2319	—1.3217	1935	2.4142	—1.4868	—1.5965
1927	2.4748	—1.2810	—1.3292	1936	2.4751	—1.4304	—1.5321
1928	2.4932	—1.2786	—1.3152				

VOL. CXIV. PART III.

(3) Simple Regressions for Data of Models

Regression of $\text{Log } \frac{x_1}{x_2}$ on $\text{Log } \frac{p_1}{p_2}$

Model	Regression Coefficient	Coefficient of Correlation
Ia and Ib	-3.15	-0.13
Ic and Id	-3.77	-0.15
Ila and I Ib	-9.62	-0.43
I Ic and I Id	-12.10	-0.52
III	-3.54	-0.50
IV	-3.47	-0.80

The demand equations for Model Ia and Ila by multiple regression are:

Model Ia

Demand for Australian-New Zealand wheat:

$$y_1 = -5.37y_3 + 4.32y_4 + 2.12z_1 + 5.53z_2$$

Demand for Argentine wheat:

$$y_2 = 0.19y_3 - 1.58y_4 + 5.24z_1 - 4.72z_2$$

Model Ila

Demand for Australian-New Zealand wheat:

$$y_1 = -0.89y_3 - 0.01y_4 + 3.26z_1 + 3.37z_2$$

Demand for rest of the world wheat:

$$y_2 = 1.91y_3 - 1.97y_4 + 0.76z_1 + 0.16z_2$$

DISCUSSION ON THE PAPER BY MR. MORGAN AND MR. CORLETT

MR. STONE: It gives me great pleasure to have this opportunity of moving a vote of thanks to Mr. Morgan and Mr. Corlett for their long and interesting paper, the more so since some years ago Mr. Corlett worked with me at the National Institute of Economic and Social Research. The general field of demand analysis is one on which a number of papers have been read to the Society in recent years, but, if my memory is correct, none has dealt with the particularly topical question of price influences in international trade, and certainly none has made a special feature of what has come to be called the "simultaneous equations approach", though the subject was referred to in Dr. Tobin's paper last year.

My comments on the paper can conveniently be divided into those dealing with methods and those on the actual results which have been obtained.

In estimating foreign trade price elasticities it has become a fairly common practice to take a short cut by using as variables the relative quantities imported from different sources and the relative prices (or more often average values) at which these alternative supplies can be bought. I remember talking to Tinbergen about this at about the time of his 1946 paper, to which the authors refer, and he emphasized that his method was intended as a short cut designed principally to overcome the lack of long series of reliable income estimates. The assumptions involved in such an approximation are, however, easily forgotten, and it is therefore extremely useful to have the clear statement of them contained in section 2 of the paper.

In the middle part of this paper the authors have elaborated the simple approach of correlating relative imports and relative prices by adding additional variables, in particular the income of the importing country, and a residual trend which is intended to absorb slowly changing influences such as tastes and habits. They remark on the dangers of multicollinearity but do not present the results of bunch map analysis, for which they can hardly be blamed, in view of the considerable additional calculation which this would have involved in a paper which already contains a quite unusual amount of numerical work. They also comment on a departure from the assumptions of classical regression methods which is likely to be present in their work, and

1951]

indeed in most work with economic time series, namely, a lack of independence in the residuals from any one of their regression equations. For the simplest case they give in a number of instances (in Table 4) a measure of this independence both for residuals obtained from the original series and for those obtained from first differences. They note some gain in randomness when first differences are used, and in fact, on the evidence, this seems considerable, so that it would be interesting to have a comparison of the means and variances of the two sets of d -ratios which could be compared with the values expected from a random series.

The importance of random residuals lies not so much in the difference that a lack of randomness is likely to make to the calculated regression coefficients, as in the difference which it makes to the relevance of estimates of sampling variances as ordinarily calculated to the assessment of the reliability of the regression coefficients. Unfortunately no estimates of the standard errors of regression coefficients are given in this part of the paper, and I think it a pity that this has not been done. It is of course easy to point to difficulties in obtaining a reliable assessment of the accuracy of these calculated coefficients, but nevertheless I think they would be valuable, particularly where the calculations are done with first differences. Without them one is thrown back almost entirely on an examination of the signs of the coefficients as a test of the method. Had the simultaneous equations approach given strikingly good results in practice it might be unnecessary to persevere with the simpler methods and so measures of their reliability would be superfluous. In fact, however, this is not the case; as the authors point out, the more complicated approach has not worked well in their particular field of application.

The comparative novelty, despite some interesting calculations by Mr. Lomax, of the simultaneous equations approach in applied work in this country makes it perhaps desirable to underline the difficulty which this approach is designed to meet. The sampling model appropriate to ordinary least squares estimation implies that the sets of values of the determining variables are fixed in repeated samples, while the dependent variable is free to vary either because of errors in the available estimates of it or because of the omission from the regression equation of other variables, by which in fact it is influenced. If the relationship studied, in this case the demand equation for imports, is one of a system of equations into which a number of simultaneously interacting variables enter, then in fact the above assumption cannot be made. This interaction of economic variables has long been an essential feature of economic theories, but it is only since Haavelmo's classical paper (*Econometrica*, 1943) that it has come to be realized that this commonplace of economic theory should influence the method of estimating the parameters that enter that theory. If the interaction of the variables in the system is ignored in estimation then the resulting estimates will be biased. From a practical point of view the question is whether, given limited resources, it is more important to remove this bias or to remove other imperfections of data or estimating procedure. Since very little is known about the actual importance of this source of bias (cf., however, L. R. Klein, *Economic Fluctuations in the United States* (Cowles Commission, 1950)) it is particularly desirable at this stage to try to appraise the improvement brought about by adopting the simultaneous equations approach.

This brings me to my second topic, namely, the results themselves. The very extent of these makes it difficult to summarize the conclusions that can be drawn from them. It appears that the single equation approach gives results for the price substitution elasticities which in at any rate a substantial majority of the cases are fairly plausible. In many cases the expected negative value of this parameter is reflected in the estimate, and it is frequently found—a fact which so far as it goes is encouraging—that there is considerable consistency in the magnitudes of these estimates from subset to subset. There are cases, however, where for some reason the method does not work. Thus for example in the three sub-analyses of the imports of iron ore from Algeria and Spain into the United Kingdom for the periods 1870–86, 1887–1900 and 1901–14, the values of the price substitution elasticity are (a) plausible in the first subperiod but usually positive in the second and third, (b) somewhat inconsistent for different subsets within each period, and (c) inconsistent within subsets between periods. The second and third of these analyses must therefore be regarded as useless. When, however, an analysis is done for the whole period 1870–1914 the results are plausible and fairly consistent, at least so far as this parameter is concerned.

The order of magnitude of these estimated price substitution elasticities seems to me about what might be expected, that is to say they tend on the whole to be somewhat higher than is found between what may be supposed to be fairly close substitutes in the case of foods. I believe also that they tend to be somewhat higher than the values found previously by other investigators for total imports from alternative sources. It might be supposed that even higher values would be found, but it seems probable that for many commodities the existence of established trading channels may make it hard to take full advantage of temporary price differentials even in the case of highly standardized articles.

The income coefficients which, as the authors suggest, may be interpreted as rough measures

of the difference between the income elasticities of demand for imports from the two sources seem mainly remarkable for their large size, and for their sensitivity in many cases to the inclusion or exclusion of a residual trend factor.

It is possible that some of these analyses could be improved by the introduction of new or different variables. Thus the abandonment of the use of ratios and the introduction of more prices (including a measure of all other prices) might be useful where there are important sources of supply other than the two explicitly considered in the analysis. This of course raises the danger of multicollinearity, but in some cases it might not be present. Again, in so far as many of the imports considered are raw materials, it might be helpful to introduce the level of activity in the principal users of these materials rather than the national income itself. This could only be done in a few cases such as iron ore and wool where the material is specific to one or at most a few trades, and where there are measures not based on imports of the activity of these trades. Finally there is the question of changes in stocks, a factor which the authors recognize explicitly in their simultaneous equation models.

In the case of the results obtained from the simultaneous equations approach it is perhaps worth while to underline the authors' comment that "the confidence regions are either very large or even infinite". At the same time many of the coefficients obtained seem almost fantastically high, in many cases of a different order of magnitude from the most nearly comparable results in the earlier part of the paper. The authors have done a great service in trying out this new method in so many cases, and it is to be hoped that the negative results which they have obtained will not discourage them from attempting a fuller explanation of the reasons. In this field of statistical analysis there are so many imperfections of data and pitfalls of method that ideal conditions of analysis are rarely met with. In these circumstances it is important for the applied economist to know which of the many partial solutions of the general problem is likely to be most serviceable to him.

I have very great pleasure in proposing a vote of thanks to Mr. Morgan and Mr. Corlett.

Mr. J. DURBIN: My first reaction on reading this paper was of admiration for the painstaking way the authors had faced up to the problems they encountered as the work progressed. In spite of the scant encouragement they received from the results and of the complexity of the later calculations they persisted in their efforts with great thoroughness. The computational burden must have been considerable, not only in calculating the coefficients, but also in compiling the data. Although the results obtained are disappointing, the paper will, I believe, be of great value both as a standard for future work of the same kind and as a clear account of the difficulties that lie in the regression analysis of economic time-series.

On the economic implications of the paper I have little to add to what Mr. Stone has said. Certainly, if one extrapolates the experience of Mr. Morgan and Mr. Corlett, the outlook for the econometrician looks rather gloomy, at least if his data consist only of annual series. There were, however, certain complicating factors in the present study which may not be so important in other applications. For example, in discussing the effects of intercorrelation between the variables under study the authors give the figure of .98 for the correlation between the two price series used in the first three models. With a correlation as high as this it is out of the question to expect any reasonable precision in the estimates of the price coefficients. This difficulty is closely allied to the problem of identification which has been troubling the econometricians so much recently, and it seems to me to be rather an intractable one. It is easy to get formal identification by adding extra variables to the model, but if the effect of these variables on the system is small, then for small samples the standard errors of the coefficients will be so large that the situation is almost as bad as if the model were not identified. Unfortunately, nothing can be done to remedy this. The point should, I think, receive more attention in discussions of identification.

I should like to comment on some of the statistical techniques used in the paper. After the elementary regressions of quantity ratios upon price ratios had proved unsatisfactory, the authors considered the effect of introducing extra variables into the regression equations. I am surprised that they did not test the effect of this statistically by calculating the additional contributions to the regression sum of squares. The question of including or omitting independent variables in a regression equation is one that often crops up in this kind of work, and Mr. Stone and his colleagues have made a good deal of use of Frisch's bunch-map analysis for the purpose. However, I am not sure that once an ordinary multiple regression approach has been decided on the straightforward significance test may not be equally illuminating.

Turning to the autocorrelation problem, I have compared the values of d calculated by the authors with tables of significance points, and found that for the original series 15 values were significant, 10 values were not significant, while for 2 values the test was inconclusive. This was for a test against position serial correlation at the 5 per cent level. For the regressions based

1951]

on first differences, only 5 values were significant, 20 values were not significant, and once again for 2 values the test was inconclusive. In this case a 5 per cent two-sided test was used. Speaking generally, it seems clear that there was a certain amount of serial correlation in the original error terms which has been reduced by means of the first difference transformation. This, however, by no means implies that the first difference transformation is the last word on the subject.

I am especially grateful to the authors for their thorough application of the simultaneous equations methods. In spite of the theoretical appeal of these methods, it is only by trying them out in practice that they can be properly appraised and given their place in standard statistical methodology. It is often said in favour of the methods that when they are appropriate the use of ordinary least squares regression would lead to biased estimates of the coefficients. Nobody seems to point out, however, that the simultaneous equations estimates are also biased for samples of finite size, although they are in fact consistent. I should like to know how large these biases are likely to be before deciding one way or the other in any particular case.

In view of the results in this paper, the question of constructing confidence regions from the simultaneous equations estimates seems to need further consideration. At first I was rather startled to find that some of the confidence regions calculated by the authors were of infinite size, but on further examination it appears that when the equation concerned is near to being unidentified, the situation is by no means unlikely. For instance, the simplest possible region of the Anderson-Rubin type is equivalent to that given by Fisher in the latest edition of *Statistical Methods* for the ratio of two normal variables. The unidentified case corresponds to the ratio of two variables with zero means. In view of the high probability of very large values of both signs, it is not surprising to find confidence regions extending to $\pm \infty$. When the means are not zero, but are small in relation to the variances, the probability of getting infinite regions is reduced but can still be fairly large.

Another result in the paper which surprised me was the high average level of the ratio s_e^2/s^2 which was calculated by the authors as a measure of the goodness of fit of their equations. On further reflection, however, I am not sure that this is a good criterion to use. What seems to be needed is a measure of the dependence of the dependent variables taken as a whole upon the predetermined variables. I would suggest, therefore, that the residual variance in an equation should be compared, not with the mean-square of a single quasi-dependent variable, but with the mean-square of the linear function of all the dependent variables occurring in the equation. Thus, in the first equation of model Ia I should have taken the ratio of s_e^2 to the mean square of $y_1 + 48.1y_3 - 40.5y_4$.

I have in fact calculated this ratio for the two demand equations in models Ia and Ib, using data kindly provided by Mr. Morgan and Mr. Corlett. The results are as follows:

Model Ia	y_1	.360	Model Ib	y_1	.523
	y_2	.579		y_2	.605

Thus we have the surprising result that the ratio has actually increased on adding the extra predetermined r_s to the equations. The multiple correlations obtained from these figures are disappointingly low, and suggest that the models have not given a very good representation of the data.

I have looked into the geometry of the problem, and it seems likely that when the equation concerned is just-identified the multiple correlation coefficient so obtained can be tested in the ordinary way. It will, however, be necessary to deduct from the number of observations the number of dependent variables in the equation less one when making the test. On this basis all the four equations I have considered show significant correlation. I believe that with the same adjustment the test for serial correlation will also be valid, and in general any regression test that depends only on the error vector being randomly directed. For the over-identified case it seems possible to obtain inequalities for the significance points.

It gives me very great pleasure to second the vote of thanks.

Professor J. E. MEADE said that he was an economist and not a statistician, and there was much in the paper that he could not understand. He would, however, mention one point which had struck him in looking at the authors' results. He thought that in every case the sign of the direct elasticity of demand was different from the sign of the cross elasticity of demand. That seemed to him odd; wherever the one sign was wrong, the other was also wrong. This suggested that the demand for a particular commodity depended upon the price ratio.

Although the paper had produced an extraordinarily interesting contribution in terms of the simultaneous-equation method, the results seemed disappointing from the economic point of view. This paper, together with one published in 1950 by Orcutt in the *Review of Economics and Statistics* (32, 117), suggested to him that quantitative estimates of substitution and demand

in international trade were quite unreliable. Orcutt's paper suggested that previous estimates were all seriously biased towards zero. It now appeared that by the new simultaneous-equation method also they could not hope to obtain reliable results. This was extremely disappointing, but what could the economists do about it? He felt that they were driven back on common sense—on a "hunch"—for the time being. He thought also that they must not stop there. Surely they must find out why these methods were unreliable, and make every effort to get quantitative estimates which could be relied on. Perhaps the statistician was required to make greater efforts to obtain data which were more exactly what he wanted. If that were so, what was the prospect of an elaborate and large scale co-operation with Government departments to give them a chance of finding out the truth?

Mr. HOUTHAKKER said he would confine himself to enlarging on some of the points made earlier in the discussion, especially by Mr. Stone. The authors' criticism of the price-ratio/quantity ratio approach in the first part of their paper was very useful. Their applications of the simultaneous equations approach invited more extensive comment. Whatever one might think of their results, the authors were entitled to our gratitude for so clearly showing the difficulties in this field and for their perseverance in undertaking their extensive calculations.

He thought that the surprising regression coefficients which the authors found in many cases resulted from multicollinearity between the predetermined variables, as in fact they themselves had indicated. Some information on this matter would be very valuable, e.g., in the form of a table of correlation coefficients which is often as illuminating as a bunch-map analysis without requiring any additional work. The place of multicollinearity in simultaneous equations regression had not yet been clarified; it would seem that the rank condition on the coefficients of the structural equations was no longer satisfied in such a case, so that the coefficients were not identified. At any rate it was useful to know that modern regression methods were apparently no less sensitive to multicollinearity than classical methods.

Apart from the question of possible multicollinearity, a remarkable fact was that in the equations with the lowest residual variance ratio (e.g., equations 9-12, 16, 25-28, 40, 45-47, 50-52) the coefficients had the most reasonable magnitudes (though still frequently the wrong signs). This suggested that in the other equations the abnormally large coefficients might arise from unrealistic assumptions about the curves which they represented. The theoretical model might postulate, for example, that a price was determined by the intersection of a demand and a supply function, both of which shifted under the influence of other variables. If the variables considered did not produce sufficient shifts to explain the prices actually observed, however, the supply or the demand curve (or both) would have to become nearly vertical, i.e., their elasticities would be very large. In this case the signs of the elasticities were no longer very interesting or reliable, for the slope of a vertical curve might equally well be called $+\infty$ or $-\infty$, and the standard errors would be large anyway. If this very tentative interpretation were correct, one could see again how crucially important was the right choice of the model (including the mathematical specification of the functions) in the simultaneous equations approach.

Having said this, Mr. Houthakker added at once that he thought the models used in the paper very reasonable, except for some minor points. He wondered if in Models I and II speculation had been adequately taken into account. In Model III investment might have been substituted for national income in view of compensatory budget policy which might have caused a negative correlation between the two; some lags might have been useful. On the other hand the lag in p in Model IV does not seem appropriate.

He objected to the conclusion at the end of the paper that because of the authors' lack of success and the difficulty of obtaining suitable data other efforts should be distrusted, for although they had done a great deal of work many possibilities were still unexplored. They had, for instance, hardly investigated non-logarithmic demand and supply functions; many mathematical types apart from the usual logarithmic and linear forms were quite suitable for linear regression analysis. The theoretical structures used could be varied to a considerable extent. Further work on one of the models might well produce more acceptable results; there appeared to be no reason for exclusive reliance on common sense, as Professor Meade seemed to imply, especially as it was difficult to see how unaided common sense worked in these complicated cases.

The authors subsequently wrote as follows:

We are most grateful to those who have contributed to the discussion of our paper.

We are not convinced that standard errors of the regression coefficients for calculations with first differences would be as valuable as Mr. Stone believes. As we indicated in the paper, it would be possible to obtain a very good fit while the coefficient did not approximate to the economic magnitude in which we were interested. A small standard error would be no guarantee

1951]

of accuracy. It is true that a large standard error would make it impossible to say that a positive coefficient was due to causes other than sampling errors. The result would still, however, be useless. In order to give some information on this point we have continued into Tables 2, 3 and 4 the system of stars for significant coefficients of correlation. Standard errors can, of course, be calculated from the data given in the tables.

We find Mr. Stone's discussion of the plausibility of the results rather baffling. An appreciable proportion of the coefficients are clearly unacceptable. There was good reason to expect the majority of them to have the correct sign. The fact that this expectation was fulfilled is hardly grounds for feeling encouraged to continue using the same methods. There do not appear to us to be any firm *a priori* limits which can be set on the magnitude of the elasticity of substitution for individual commodities from different sources. The fact that the results are of somewhat the same order of magnitude as results previously obtained by similar methods is no evidence of their being correct if the methods themselves are wrong.

We agree that on theoretical grounds there is a strong case for including other variables in many of the analyses but doubt whether there would be any practical gain.

We agree with most of the points made by Mr. Durbin and wish to thank him for his analysis of our values of d . We trust this gives Mr. Stone the information he seeks on the d -ratios.

We admit that our ratio $\frac{S_e^2}{S_y^2}$ is not a suitable ratio for a statistical measure of goodness of fit.

It is clear that for this purpose we are not justified in using the mean square of only one of the dependent variables. The ratio was not, however, intended for this purpose. As stated in the paper, we felt, perhaps wrongly, that the size of the ratio given is of some importance to an economist using the equation. Even if the general fit of the equation were good, it would not be possible to obtain a reasonable estimate of the effect of a given price policy, for instance, if the ratio $\frac{S_e^2}{S_y^2}$ were large.

We should be interested to see a proof of Mr. Durbin's suggestion that the mean square of a linear function of all the dependent variables can be used as the basis of an ordinary test of a multiple correlation coefficient when the equation is just identified.

We think the explanation of the fact, on which Professor Meade commented, that the average value figures had opposite signs in every demand equation lies mainly in the high correlation between the two average values. The sum of the two elasticities is comparatively stable and not very large but the individual figures are not stable. Thus if one becomes large and positive, the other must be large and negative. We do not believe it safe to deduce that the demand depends on the price ratio.

It is true that in the just identified case the existence of a linear relationship (not necessarily multicollinearity) between the predetermined variables would prevent the rank condition for identification being satisfied, as suggested by Mr. Houthakker. When the equation is over-identified the position is not quite as simple. It would appear necessary for there to be one more linear (or approximately linear) relation than there are predetermined variables in excess of the number required for identification. If this suggestion is correct the interpretation of the table of correlation coefficients between the predetermined variables would not be easy.

We are afraid Mr. Houthakker is misusing our ratio $\frac{S_e^2}{S_y^2}$. It follows almost automatically from the method of construction of this ratio that it is high when the coefficients of the average values are large. The ratio cannot be used to test whether one equation is a better or worse fit than another. For this purpose one would have to use a statistical measure of goodness of fit such as that suggested by Mr. Durbin, which depends on all the dependent variables.

Our form of equations may well be incorrect and we may well have left out variables which are of importance. A glance at the multiple correlation coefficients of the reduced form equations bears this out in some cases. The result will certainly be large errors in the coefficients, but we do not understand Mr. Houthakker's argument that this will lead to nearly vertical supply or demand curves and so to very large elasticities.

We considered including speculation more specifically in Models I and II but did not find a satisfactory way of doing so. Speculative elements do, of course, enter to some extent through stocks and lagged prices.

The demand relevant to Model III is partly a consumption and partly an investment demand. The choice between using national income or investment is close and we may well have made the less satisfactory one.

We have a certain sympathy with Mr. Houthakker respecting the lagged price in Model IV.

We did not intend our conclusion to imply that no work in this field could ever be successful. We do, however, feel extremely hesitant about accepting any results yet published. We also

think that a strong case needs to be made out before the validity of results obtained by further work is established. We trust we have Mr. Houthakker's agreement on this point, and that his "more acceptable results" do not simply mean results in greater conformity with unaided common sense.

As a result of the ballot taken during the meeting the candidates named below were elected Fellows of the Society:

John Leslie Anderson.
Albert George Antill.
Joseph Ronald Bainbridge.
James Henry Cadwell.
Chandra Jagdish Chaturvedi.
Arthur Irving Godfrey.
Richard Lloyd Gwilt.
Alfred Trevor Haynes.
Hendrik Samuel Houthakker.
Reginald Douglas Lord.
John Arthur Mulligan.

Colin Strathern Penn.
Leon John Puddicombe.
John Muirhead Ross.
D. A. B. Scrimgeour.
Edward Harry Slade.
Andrew Smith.
John Stringer.
Sim Hong Tan.
George David Wilcock.
Robert Henry Woodward.
Jan Wacław Zalewski.

Corporate Representative

Ernest Donald Snelling, *representing* Gillette Industries, Ltd.

1951]

SOME CALCULATIONS ON ELECTRICITY CONSUMPTION IN GREAT BRITAIN

By H. S. HOUTHAKKER

University of Cambridge, Department of Applied Economics

0. Introduction

THIS inquiry consists of two parts, viz., an analysis of electricity demand on domestic two-part tariffs for 42 provincial towns in 1937-38, and an investigation of monthly fluctuations in generation. It was originally hoped to incorporate these two calculations in a comprehensive study of the various components of electricity consumption, but the available information proved to be insufficient. The results here presented, which are largely based on hitherto unpublished figures, and the methods used in obtaining them may nevertheless be of some interest.*

1. Demand on Domestic Two-part Tariffs in 1937-38

1.0.0. In any demand analysis the principal explanatory variables will be income, the price of the commodity under consideration, and the prices of such complementary or competing goods as are considered sufficiently closely related to exercise a noticeable influence. In addition it may be necessary to introduce extra-economic factors to account for differences in preferences between consumers; for the rest preferences are assumed to be affected only by random disturbances. We shall first consider in some detail what variables should enter into a demand equation for electricity; then, after having explained the method of analysis here followed, we shall discuss how the series for these variables were arrived at.

1.0.1. The *income* variable relevant for our purpose is evidently the income of the consumers to which the observations refer, i.e., of the private households with two-part tariffs in the towns considered. As is well known, such tariffs consist of a periodical fixed charge, determined usually by the rateable value or the floor area of the house and always independent of actual consumption, and a running charge proportional to the number of kilowatt-hours used (with possibly some modifications that will be mentioned below). Consumers can choose to be charged according to either a flat rate or a two-part tariff,† whichever is cheaper. Under a two-part tariff total outlay will be smaller than under a flat rate if the saving in running charges more than offsets the fixed charge, which will be the case if consumption exceeds a certain level. If the flat rate and both components of the two-part tariff are given electricity consumption, and consequently the tariff applied, will depend mainly on income. This will be true even if the fixed charge is related to income through rateable value, etc., for it is a well-established fact that the income-elasticity of housing expenditure is less than unity, and less, in fact, than the income-elasticity of the total outlay on electricity.‡ Moreover, where the fixed charge was based on rateable value it was usually a decreasing proportion of the latter. Another reason for expecting two-part tariff consumers to be the households with the highest incomes is that such consumers nearly always enjoy credit facilities, whereas a flat rate is very frequently combined with a slot meter. This theory about the incomes of two-part consumers is confirmed by statistical checks (cf. 1.5.0 and the second footnote in 1.6.0).

* Acknowledgement is made to a number of economists and electrical engineers for valuable suggestions, and especially to Mr. J. R. N. Stone, Director of the Department of Applied Economics, for his stimulating interest and advice. The Ministry of Fuel and Power kindly allowed me to use some statistics collected by the former Electricity Commissioners; the British Electricity Authority was also very helpful in these and other matters. The large amount of computation was mainly carried out at the Department under the supervision of Mrs. E. M. Chambers.

† These and other tariff types are discussed by Bolton (1943) and Houthakker (1951).

‡ In a subsample of the 1937-38 Ministry of Labour budget survey the elasticity with respect to total expenditure of "rent or purchase of dwelling, rates, etc." was found to be 0.62 (with a standard error of 0.06) and that of electricity outlay was 1.31 (± 0.21).

1.0.2. Under a two-part tariff the *own price* variable has two components: the fixed charge and the running charge. Once the choice of tariff type has been made—and we have seen this depends mainly* on total outlay or, what amounts to the same, on the average price per kWh—the marginal price will be chiefly relevant. The fixed charge has to be paid irrespective of consumption and will therefore have only an insignificant income effect on consumption. The amount consumed will be determined by a comparison between the utility of an additional kWh and of alternative ways of spending its money cost, i.e., the running charge for one kWh. This argument, obvious though it may seem to the economist, has been overlooked in many (but not all) of the demand studies occurring in the electrical literature. It is very easy to collect average prices and sales per consumer for a number of undertakings, draw a curve through the scatter diagram thus obtained, and call the result a demand curve. Unfortunately this procedure has no economic significance. The average price under a two-part tariff depends not only on the running charge and the fixed charge, but also on the amount consumed itself, and is therefore not an independent variable in the economic or statistical sense. If consumption is affected by income and other variables the average price will vary too, but the resulting purely arithmetical relationship between consumption and average price affords no information as to the influence of tariff changes on demand. Even if income, etc., are introduced as separate variables in a multiple regression analysis (and in the type of work here criticized this is rarely done) the probability distributions of consumption and average price will not be independent, thus causing formidable statistical difficulties.

1.0.3. Among *prices of competing commodities* gas tariffs will no doubt be most important, although the field on which gas and electricity compete is really rather limited for consumers who are supplied with both, so that we cannot expect a high cross-elasticity. Gas is usually sold on block tariffs (with a marginal price dependent on the amount bought) which are rather inconvenient from a statistical point of view unless we use a meaningless average price; a simplification of the data was therefore necessary (cf. 1.3.0).

1.0.4. Electricity is always used in conjunction with *complementary goods*, whose importance will vary with their power consumption. Heavy electrical equipment, such as cookers and boilers, will therefore require special attention, the more so because they are held in very different amounts by different groups of consumers. The durable nature of these implements invites the use of hire-purchase methods, notably by the electricity supply undertakings themselves. Some undertakings made the sale of heavy domestic equipment on favourable terms the basis of their policy of expansion. The exact conditions of sale cannot easily be reduced to statistical variables, if only because one would have to go back over the whole period in which the existing equipment was bought. On the other hand, since we do not propose to explain consumers' holdings of such equipment, but only their influence on electricity consumption, it will be sufficient for our purposes to consider actual holdings of heavy domestic appliances as representative of the past and present prices of complementary goods.

1.0.5. Apart from these "economic" variables there will no doubt be many special factors that cause differences in consumption between consumers, but it is difficult to think of one sufficiently definite and outstanding to be introduced explicitly. We shall therefore subsume these influences as a random disturbance. Our demand equation is therefore of the form

$$F(x, M, p, g, h, \epsilon) = 0 \quad (1)$$

where

- x = average annual electricity consumption per consumer with a domestic two-part tariff.
- M = average money income per household with a domestic two-part tariff.
- p = marginal price of electricity on domestic two-part tariffs.
- g = marginal price of gas on domestic tariffs.
- h = average holdings of heavy domestic equipment per consumer.
- ϵ = random disturbance

1.1.0. We must now discuss two points concerning this equation: first, to what periods do the variables refer; and second, is the equation identifiable? Anticipating our empirical results

* A rather complicated consumer's surplus problem arises here, the answer to which depends on whether production costs are taken into account. Cf. Houthakker (1951), pp. 13–14.

1951]

for a moment we should add that the demand functions used in our final equations are sums of one-variable functions; thus (1) can be written as

$$f_0(x) = f_1(M) + f_2(p) + f_3(g) + f_4(h) + \varepsilon \quad (2)$$

Equations that cannot be written in this form were also considered, but they did not seem to lead to higher accuracy. In the absence of a theory of the shape of demand curves the statistically more convenient type (2) has therefore been preferred.

1.1.1. The first problem, that of dating the explanatory variables, can best be solved by the observations themselves. Owing to the complementarity with durable goods substantial lags in the influence of income, own price and gas price may be expected, but the way in which complementary goods were allowed for makes a lag in this particular variable improbable.

1.1.2. The identifiability* of (2) depends largely on the answer to the previous problem, that of lags. We shall see, in fact, that considerable lags occur in the influence of p and g and that M and h are introduced in such a way that they represent accumulated variables. Consequently no variable on the right-hand side of (2) was jointly determined with x itself, and it is unnecessary to set up a model describing how M , p , g and h were actually determined in the relevant periods.† The parameters in (2) are therefore identified.

1.2.0. In order to estimate the parameters in (2) we have used the method of geographical comparison, which is based on data referring to different localities for the same period, rather than the more usual time-series analysis. The former method is of course only applicable where the predetermined variables show sufficient variation, but since from the economic and statistical point of view the two methods are virtually identical the choice between them is a matter of convenience rather than principle.

1.2.1. In the present case geographical comparison has been preferred for the following reasons:

(a) Electricity is (or was) sold by local monopolists whose sales policies showed so little uniformity that the variable p assumed very different values in our sample. The same holds for gas and for complementary goods supplied by power undertakings. On the other hand the general price level (more accurately: the prices of all goods not separately considered) will be much the same for individual towns that do not vary too much in size.

(b) These differences in prices between various parts of one country diminish the economic significance of a national average, quite apart from the vast amount of work required to construct a national average of marginal prices. A national average of average prices is available, but in 1.0.2 we have stated serious objections to the use of this variable in a demand equation.

(c) Not all families consume electricity; therefore national income is not an appropriate variable and should be replaced by a figure derived from the distribution of family incomes. Continuous information about the latter is notoriously lacking, but for 1937 some basic estimates are available.

(d) As regards accuracy and relevance the available time series are markedly inferior to the data we shall now describe.

1.2.2. The Electricity Commissioners, who until recently supervised electricity supply in Great Britain, collected a considerable amount of information on various aspects of the industry. Part of this was published, though not in a form very useful for the present purpose. The original questionnaires submitted by undertakings, especially the *Financial Returns* and also the *Supplementary Statistical Returns*, contained much more interesting figures.‡ This information was first asked for in the early thirties, but the response of the industry was hesitant at first and when in 1939 the questionnaires had to be simplified, a complete coverage had not yet been

* Cf. Koopmans (1949); Koopmans *et al.* (1950).

† This task would be quite difficult, for the wide variations in the price policies of different local authorities (to which our observations refer) could hardly be explained by economic considerations alone.

‡ Students of industrial consumption of electricity would also find much of interest here.

achieved. The year 1937/38* is the last for which audited returns are available and has therefore been used here.

1.2.3. The towns to which the analysis refers were chosen according to the following criteria:

(a) Income estimates from the *Marketing Survey* (cf. 1.3.1) had to be available; this was the case for about 110 towns.

(b) The population of the area supplied by the undertaking should not exceed the population of the town itself by more than 15 per cent. (since income figures were available only for the latter), except in one or two cases where additional data could be used.

(c) There had to be at least 1,000 two-part consumers during the period and the alternative tariffs offered for domestic supplies had to be such as to attract only small consumers.

Restriction *a* excluded the London area, in which *b* would not have been satisfied in any case. Restriction *b* caused the exclusion of the few towns where a private company operated, since companies were naturally less influenced by administrative boundaries than local authorities. Restriction *c*, which excluded only a small number of towns, was introduced with a view to our theory about the incomes of two-part consumers (cf. 1.0.1).

1.2.4. Thus we finally arrived at a sample of 42 towns, details of which are given in Table 2. Although the selection was not random it will be seen that they are well distributed as regards size and region.

1.3.0. We shall now describe how the series for the variables x , M , p , g and h were obtained. Average consumption per two-part consumer could be found directly from the *Financial Returns*, which contained all the relevant figures. We shall deal with the income series separately. Electricity prices were derived from Garcke's *Manual of Electrical Undertakings* and from the *Electrical Times Booklet on Tariffs and Voltages* (1938). In some cases a summer rebate was given; this was allowed for by taking an average running charge for the whole year.† Gas prices appeared in the *Returns Relating to all Authorized Gas Undertakings in Great Britain* (Board of Trade); they were checked with various other sources since the official figures seemed occasionally open to doubt. Where necessary the difficulty about block tariffs (cf. 1.0.3) was eliminated by using the average price per therm paid by domestic consumers at an annual consumption of 100 and 500 therms, as given in the Board of Trade returns. The slope of the outlay curve between those points was used as an approximation to the marginal price; since the actual marginal price decreased but little in this range the inaccuracy caused by this procedure should be very small.

1.3.1. The income variable presented much greater difficulties. Our basic source was the *Marketing Survey of the United Kingdom* (3rd Edition, 1938, editor Cecil Chisholm), which divided the private families in each town into four social classes according to the estimated income of the head of the household. This classification was based on occupation and wage-rates for manual workers and on housing figures (number of persons per room) for others. Several rough checks indicated that these figures deserve considerable confidence. For our purpose the relevant variable was not the income (before tax) of the head of the household however, but total family income after tax; moreover, we did not want the number of families within certain limits but the average income of the top P per cent. of households in a town, where P per cent. is the proportion of two-part consumers to the total number of families (cf. 1.0.1).‡ It was therefore necessary to estimate the net family income of families where the gross income of the head belonged to a certain range.

1.3.2. This calculation was carried out with the aid of two other sources of information: the distribution of income-tax units by income before tax in 1937 as given by Barna (1945) and additional figures about private families in 1937 from *The Home Market* (1939 edition, by G. Harrison and F. C. Mitchell). The latter publication is very similar to the *Marketing Survey* but contains national totals for its income classes as well; on the other hand it gives details for

* This period began on April 1st for local corporations in England and Wales and on various dates in May for Scotland.

† Because of the small number of towns where this seasonal tariff existed a separate analysis of winter and summer demand proved inconclusive.

‡ Each consumer is assumed to correspond to one household.

1951]

fewer individual towns and therefore could not be used as the main source for income figures. Where the *Marketing Survey* and *The Home Market* could be compared they appeared to agree fairly closely; some adjustment was necessary because the class limits were not the same everywhere. For the calculations in Table 1 it was also necessary to know the number of supplementary earners (i.e., recipients of—earned or unearned—incomes who do not belong to the same income-tax unit as the head of their family) classified by the gross income of the head. On this subject hardly any information is available* and the figures used in Table 1 (columns 6–9) can only be described as guesses. Experiments with widely varying assumptions suggested that despite the crudity of the method the error in the final results (an error of weighting, since total income is fixed) does not exceed 10 per cent.

1.3.3. Table 1 and the notes following it illustrate the method of calculation.

1.3.4. In this way we get estimates for the average disposable family income of all A-, B-, C- and D-families in the country (i.e., of families where the gross income of the head belonged to the range given in Col. 1 of Table 1). These averages were then applied to the households with two-part tariffs in each town, on the theory explained in 1.0.1.† Thus, if there were 10,000 two-part consumers in a town with 3,000 A-families, 5,000 B-families, 18,000 C-families and 15,000 D-families, the average income of these consumers was taken to be

$$\frac{3,000 \times 1,422 + 5,000 \times 443 + 2,000 \times 260}{10,000} = 700$$

The fact that within some income-class (the C-class in the above example) some households had two-part tariffs and some had not was not taken into account; thus allowance was made—in a rather crude fashion—for the possibility that the theory referred to did not hold exactly but only stochastically. It will be seen that a high income figure for a town indicates a relatively small number of two-part consumers rather than general prosperity (cf. also 1.5.0).

1.3.5. Finally, there is the variable representing *complementary goods*. The "Supplementary Statistical Returns" collected by the Electricity Commissioners gave for each town the number and kilowatt rating of various types of domestic equipment, with separate figures for implements supplied on hire-purchase schemes (for some towns not all figures were available, but where the information was too incomplete the town had already been excluded altogether). Since the cash prices for domestic equipment could not have varied significantly between towns only apparatus paid in instalments was relevant for the present analysis; moreover, only heavy equipment (cookers, water heaters and wash boilers) was considered since this was the special object of sales promotion by the undertakings. The total kilowatt rating of heavy equipment on hire purchase then had to be allocated between consumers with two-part tariffs and with other tariffs (in practice, with a special rate for heating and cooking). Some calculations suggested that the most suitable ratio for allocation would be $m_1/p_1 : m_2/p_2$ where m_1 and m_2 are the total income of two-part and other tariff consumers in each town respectively (estimated as above), p_1 the running charge in the two-part tariff and p_2 the heating and cooking rate, which was usually about twice as much as p_1 .

1.4.0. The series used, with some other relevant information, are given in Table 2. We can now proceed to the actual regression analyses. A considerable number of different forms of equation (1) were investigated, but since the final forms (3) and (4) proved definitely superior a post-mortem on the others need not be given here. The variations consisted mainly in allowing for interactions between M , p and h .

1.4.1. In the calculations the figures for each town were weighted by the number of consumers, the theory being that for each individual consumer the error term in (2) is a normal variable independent of the predetermined variables and of the errors in the corresponding equation for other consumers. The variance of the error term in the average for a town will then be inversely proportional to the number of consumers.

* The two household budget surveys of 1937–38 and 1938–39 are only of limited assistance in this respect.

† In the two cases (Coventry and Ipswich) where the *Marketing Survey* and *The Home Market* showed a distinct discrepancy in their income estimates an average of the two sources was used.

TABLE 1

(1) Range of Gross Income (£)	(2) No. of Incomes (1,000)	(3) Dispos- able Income (£10 ⁶)	(4) Average Dispos- able Income (£)	(5) No. of Incomes of Heads (1,000)	(6) Supplementary Earners			(10) in A- fam.	(11) in B- fam. (1,000)	(12) in C- fam. (1,000)	(13) in D- fam.	(14) Disp. Income in Each Cell (£10 ⁶)			(18) All fam.
					in A- fam.	in B- fam. (1,000)	in C- fam. (1,000)					A- fam.	B- fam.	C- fam.	D- fam.
A > 500	760	859	1,128	650	110	—	—	760	—	—	—	859	—	—	859
B 250-500	1,890	605	320	1,700	60	130	—	60	1,830	—	—	19	586	—	605
C 125-250	7,350	1,256	171	6,000	150	500	700	150	500	6,700	—	26	86	1,144	1,256
D 125 >	13,000	1,159	89	3,900	250	900	4,650	250	900	4,650	7,200	22	80	415	1,159
Total	23,000	3,879	—	12,250	570	1,530	5,350	3,300	3,230	11,350	7,200	925	753	1,560	3,879

Average Disposable Income per family in £ 1,422 443 260 165

Notes on Table 1:

Col. (2) from (Barna, 1945), Tables 13 and 15, except figure for D-class.

Col. (3) from (Barna, 1945), Tables 13, 15, 32.

Col. (4) = Col. (3)/Col. (2).

Col. (5) from *The Home Market*, 1939 edition, p. 65, with some interpolation.

Col. (6), (7), (8), (9) cf. end of 1.3.2.

Col. (10) = Col. (5) + Col. (6); similarly for (11), (12), (13).

Col. (14) = Col. (4) × Col. (10); similarly for (15), (16), (17).

Col. (18) = Col. (14) + Col. (15) + Col. (16) + Col. (17) = Col. (3).

The last line of Col. (14) is the total divided by the number of A-families in Col. (5); similarly for (15), (16), (17).

(Key to columns), Table 2.

Col. (1) Average number of consumers with domestic two-part tariffs in 1937-38 (thousands).

Col. (2) *Ibid.* as percentage of all families in area supplied.

Col. (3) Average income of two-part consumers (£ per year).

Col. (4) Running charge on domestic two-part tariffs in 1933-34 (pence per kWh).

Col. (5) *Ibid.* in 1935-36.Col. (6) *Ibid.* in 1937-38.

Col. (7) Marginal price of gas in 1935-36 (pence per therm).

Col. (8) *Ibid.* in 1937-38.

Col. (9) Average holdings of heavy electric equipment bought on hire purchase by domestic two-part consumers in 1937-38 (kW).

Col. (10) Consumption on domestic two-part tariffs per consumer in 1937-38 (kWh).

Col. (11) *Ibid.* as calculated from equation (5).Col. (12) *Ibid.* as calculated from equation (6).

Col. (13) Col. (10) - Col. (11).

Col. (14) Col. (10) - Col. (12).

Col. (15) Square of Col. (13) weighted by Col. (1).

Col. (16) Square of Col. (14) weighted by Col. (1).

Col. (17) Average total expenditure on electricity by two-part consumers in 1937-38 (in £).

1951]

TABLE 2

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Aberdeen	9.6	19.8	629	0.50	0.33	0.33	4.2	4.2	0.20	1,772	1,849	1,635	-77	+137	59	188	4.437
Barnsley	13.7	78.5	279	0.48	0.48	0.48	10.5	10.5	0.40	532	774	630	-242	-98	820	134	2.819
Bath	6.3	28.2	788	0.55	0.53	0.42	5.5	4.5	1.16	2,133	1,821	1,974	+312	+159	584	152	5.916
Birmingham	88.7	31.0	486	0.75	0.63	0.50	7.1	7.3	0.31	874	809	838	+65	+36	376	115	4.022
Blackburn	11.8	29.1	403	1.00	0.68	0.50	9.0	9.0	0.29	758	606	649	+152	+109	277	143	4.140
Blackpool	8.9	28.0	730	0.50	0.50	0.50	6.6	6.6	0.73	1,989	1,726	1,886	+263	+103	622	95	7.466
Bolton	31.3	66.2	324	0.50	0.50	0.48	4.5	4.5	0.77	550	683	680	-133	-130	548	524	3.111
Bristol	41.7	33.2	539	0.50	0.50	0.42	7.3	7.6	0.88	1,478	1,339	1,396	+139	+82	811	282	5.048
Bury	10.6	65.1	325	0.75	0.50	0.50	6.1	10.4	0.28	431	619	610	-189	-180	393	352	2.941
Cardiff	7.5	13.6	868	0.56	0.63	0.63	8.5	8.5	0.38	1,647	1,896	1,946	-249	-299	434	626	4.769
Coventry	25.3	41.3	497	0.75	0.63	0.50	7.3	4.2	0.49	1,358	1,320	1,359	+37	-205	714	1,051	3.081
Darlington	4.8	24.0	575	0.75	0.50	0.45	10.0	10.0	0.26	1,041	1,224	1,136	-183	-95	100	27	4.784
Dewsbury	2.5	16.9	513	0.75	0.50	0.50	6.8	6.8	0.05	661	603	534	+58	+127	44	210	3.934
Dundee	13.4	27.8	431	0.65	0.62	0.48	8.0	8.2	0.95	1,370	1,728	1,899	-358	-529	897	1,959	6.062
Exeter	6.9	33.6	681	0.75	0.50	0.43	5.8	6.0	2.52	1,052	1,275	974	-223	+78	995	122	4.019
Halifax	20.4	71.1	352	0.50	0.50	0.42	4.8	4.8	0.28	2,205	3,061	3,332	-856	-1,127	2,198	3,810	8.351
Hove	34.6	82.9	313	0.50	0.50	0.46	4.8	4.8	1.28	804	808	725	-4	+79	1	218	2.690
Huddersfield	3.1	18.6	1,301	0.50	0.45	0.45	8.6	8.6	0.71	1,939	1,944	2,188	-5	-249	—	372	6.706
Ipswich	6.0	22.3	733	0.50	0.50	0.50	7.2	7.2	0.30	896	881	844	+15	+52	14	165	3.590
Leeds	60.6	45.6	413	0.50	0.50	0.50	9.2	9.2	1.59	1,697	1,411	1,337	+286	+360	2,536	4,018	6.352
Leicester	30.7	40.6	455	0.50	0.50	0.50	8.2	8.2	1.57	808	904	853	-96	-45	74	16	4.143
Lincoln	26.7	14.7	715	0.50	0.75	0.65	7.4	7.6	1.07	1,900	1,815	2,017	+85	-117	267	506	7.353
Liverpool and Bootle	56.4	26.4	501	0.50	0.50	0.50	9.7	9.7	0.67	1,314	1,295	1,299	+19	+15	20	13	5.095
Manchester	10.3	68.8	293	0.75	0.75	0.75	11.0	11.0	0.64	608	962	778	-354	-170	1,253	289	2.314
Motherwell and Wishaw	1.3	4.7	1,422	0.75	0.75	0.75	11.0	11.0	0.64	2,026	3,124	3,107	-1,098	-1,081	1,206	1,169	10.512
Newport (Mon.)	18.5	81.9	300	0.75	0.63	0.63	6.8	7.0	0.86	555	503	568	+52	-13	51	3	2.994
Paisley	6.5	11.2	731	0.90	0.50	0.50	6.7	7.3	0.14	1,811	1,571	1,412	+240	+399	403	1,114	5.783
Plymouth	2.6	9.6	1,055	0.50	0.50	0.50	7.2	7.8	0.87	2,427	2,561	3,044	-134	-617	54	1,142	8.471
Reading	7.9	27.9	394	0.50	0.50	0.50	9.4	9.4	1.82	1,304	1,338	1,164	-34	+140	9	157	4.630
Roehdale	38.5	64.8	335	0.65	0.65	0.65	8.5	8.7	1.17	704	704	690	—	+14	—	8	3.454
Salford	2.2	7.3	698	0.75	0.75	0.75	9.0	9.0	0.03	798	1,153	772	-355	+26	252	1	5.426
South Shields	8.6	23.2	566	0.50	0.50	0.50	6.9	6.9	0.14	853	1,190	1,062	-337	-209	1,022	393	5.426
Stockport	2.2	13.2	705	0.75	0.75	0.50	8.1	8.1	0.39	1,394	1,228	1,174	+166	+220	55	97	6.088
Stockton-on-Tees	5.5	8.0	614	0.38	0.38	0.38	6.0	6.0	0.92	920	1,745	1,728	+295	+312	522	584	6.402
Stoke-on-Trent	17.4	45.9	375	0.50	0.50	0.55	7.6	7.6	0.03	673	907	885	+13	+35	3	20	3.359
Sunderland	1.3	7.5	1,017	0.65	0.65	0.65	9.1	9.1	0.95	782	1,088	1,264	-1,307	-591	1,708	349	4.029
Tynemouth	5.3	35.9	393	0.60	0.50	0.50	7.5	7.5	0.17	3,183	3,258	3,265	-306	-245	468	300	3.827
Wakefield	2.2	9.0	1,422	0.50	0.50	0.50	8.3	8.5	0.45	632	751	701	-75	-82	11	13	8.726
Wallasey	10.6	55.1	323	0.75	0.50	0.50	8.3	8.3	0.53	767	1,059	1,045	-119	-69	156	52	3.159
West Bromwich	7.6	43.1	444	0.75	0.50	0.50	8.9	8.9	0.51	1,877	1,271	1,280	-292	-278	682	618	4.237
West Hartlepool	8.9	21.7	524	0.60	0.50	0.50	8.3	8.3	0.51	1,877	1,271	1,280	+605	+597	3,294	3,208	6.597
Wolverhampton																	

(For key to columns see p. 364).

1.4.2. The final forms for (1) to which the data were fitted are as follows:

$$x = aM + b/p + cg + dh + \varepsilon \quad (3)$$

and

$$\log x = \alpha \log M + \beta \log p + \gamma \log g + \delta \log h + \varepsilon' \quad (4)$$

The logarithmic equation (4) is of the type used by most demand analysts, chiefly because it produces constant elasticities. It is worth while seeing, however, if another mathematical specification does not give a better fit. Equation (3) is linear in all variables except p ; the scatter diagrams suggested that the *ceteris paribus* influence of p was of a hyperbolic nature. Strictly speaking (3) is also more consistent with the aggregation procedure in the present inquiry than (4), as it can certainly not be assumed here that the distribution of income is the same for all towns (cf. (De Wolff, 1941) and (Tobin, 1950)). In fact α in (4) turns out to be very close to unity, so that the aggregation error in that equation should be small.

1.4.3. The variables in (3) and (4) were dated by inspection of the elementary correlations between a number of possible series. No lag was tried for M , since the methods by which the basic information on income were derived clearly reflect long-term levels (the "standard of living") rather than short-term fluctuations. As h is a stock variable, representing apparatus actually in use during the period considered, a lag would seem to be inappropriate. For p three different dates were tried, viz., the current price (p_0) and the prices two years ago (p_{-2}) and four years ago (p_{-4}) (since prices did not change very often it would not have been profitable to investigate intermediate dates). In the case of g , where price changes were also infrequent, only the current price (g_0) and the price two years ago (g_{-2}) were considered.

1.4.4. Tables 3 and 4 give the elementary correlations for equations (3) and (4) respectively.

TABLE 3

	x	M	$1/p_{-4}$	$1/p_{-2}$	$1/p_0$	g_{-2}	g_0	h
x	1							
M	.802	1						
p_{-4}	.428	.108	1					
p_{-2}	.430	.139	.711	1				
p_0	.296	.138	.450	.662	1			
g_{-2}	.150	.117	-.139	-.203	-.392	1		
g_0	.078	.077	-.216	-.208	-.406	.919	1	
h	.145	-.204	.283	.059	-.006	-.036	-.070	1

TABLE 4

	$\log x$	$\log M$	$\log p_{-4}$	$\log p_{-2}$	$\log p_0$	$\log g_{-2}$	$\log g_0$	$\log h$
$\log x$	1							
$\log M$	.815	1						
$\log p_{-4}$	-.418	-.091	1					
$\log p_{-2}$	-.402	-.123	.725	1				
$\log p_0$	-.325	-.167	.448	.674	1			
$\log g_{-2}$	.198	.185	.180	.239	.399	1		
$\log g_0$	.102	.130	.249	.240	.408	.927	1	
$\log h$	.179	-.220	-.309	-.111	.046	.007	-.030	1

There is little difference between Tables 3 and 4 and we can discuss them together. As one would expect, p_{-4} , p_{-2} and p_0 , and still more so g_{-2} and g_0 , are fairly highly intercorrelated, so that it is advisable to introduce only one from each of these two groups. Among the own-price variables p_0 is evidently less significant than p_{-4} and p_{-2} ; in the same way g_{-2} is definitely better than g_0 . The choice between p_{-4} and p_{-2} is more difficult, the decisive factor in favour of p_{-2} being the correlation between p_{-4} and h . The final set of variables then becomes (x , M , p_{-2} , g_{-2} , h) and it will be seen that the intercorrelations between them are all quite small.*

* The argument in this paragraph takes the places of two eight-variable bunch map analyses, which would have required more work than would have been justified by the conceivable conclusions. The no less formidable task of computing weighted sums of squares and cross-products of 10 variables (including two not given in the tables) was carried out on the EDSAC, the electronic computer of the University Mathematical Laboratory in Cambridge. An account of the application of the EDSAC to statistical work will be given elsewhere. I am greatly indebted to Dr. M. V. Wilkes, Director of the Laboratory, and his collaborators for their help.

1951]

1.4.5. The estimates for the parameters in (3) and (4), with their standard errors in brackets, yield the following demand equations:

$$x = 2.378(\pm .199)M + \frac{609.2(\pm 123.7)}{p_{-2}} + 41.58(\pm 20.61)g_{-2} + 270.1(\pm 60.6)h - 1,700.0 \quad (5)$$

and

$$\log x = 1.166(\pm .088) \log M - .8928(\pm .1905) \log p_{-2} \\ + .2107(\pm .1165) \log g_{-2} + .1767(\pm .0328) \log h + \text{constant} . \quad (6)$$

The multiple correlation coefficients are for (5) $R = .920$ and for (6) $R = .934$. To compare the fit it is better to replace R in the case of (6) by the so-called correlation index, which is the correlation coefficient between the observed x and the values of x (not $\log x$) computed from (6) (properly weighted), as shown in Col. 12 of Table 2; the value thus obtained is .918 and it will be seen that from this point of view there is very little to choose between (5) and (6).

1.4.6. Both in (5) and in (6) all the coefficients have the right sign and they are nearly all significant at the 5 per cent. level for 37 degrees of freedom, the exception being the coefficient of g_{-2} in (6) which however is nearly significant. The order of magnitude of the elasticities of x with respect to M , p_{-2} and g_{-2} in (6) is eminently plausible. As (5) does not yield constant elasticities we have calculated these at the point $M = 500$, $p_{-2} = .50$, $g = 8.0$, $h = .50$ (i.e., $x = 1,171$), obtaining respectively 1.01, -1.04, .28 and .12. These values are close to those occurring in (6) and therefore equally reasonable. The only coefficients about which there might be some doubt are those of h . According to (5) a 1 kW increase of holdings of heavy equipment on hire-purchase increases annual consumption by only 270 kWh, indicating a load-factor of 3 per cent. Considering that this equipment consists mainly of cookers, which will in general be used only at partial capacity and for a few hours a day, this load-factor does not seem unduly low. (A further analysis according to different types of equipment could not be attempted here.)

1.5.0. To conclude this part of the inquiry we shall report briefly on some other calculations. In the first place the crucial argument on the income of two-part consumers developed in 1.0.1 has been checked by correlating x with the average income of all households in each of the 42 towns, assuming that the two-part consumers are a random sample from all families. If we call this average income M' , the (weighted) correlation between M' and x turns out to be .554,* against .802 for r_{xM} ; moreover, $r_{MM'} = .674$. Hence the correlation between x and M' is almost entirely due to the fact that M' is a rather poor approximation of M . In fact, if one took a weighted average of M and M' (thus making more allowance for errors in the theory, which will necessarily reduce the calculated income) M would be so much more heavily weighted than M' that the use of M alone seems to be entirely justified.

1.5.1. Two variables that were considered but not introduced into the final equations (3) and (4) are the fixed charge (cf. 1.0.2) and the price of domestic coal. The average fixed charge per consumer could be calculated from the Electricity Commissioners' questionnaires; its influence was not statistically significant, not only for the economic reasons given above, but also because it was highly intercorrelated with M , as one would expect. The statistical information on coal prices in the towns considered is rather sketchy, but appears to be sufficient to exclude coal as an important substitute for electricity. Some support for this conclusion can also be derived from the residuals given in Table 2. Regional differences in coal prices depend on the distance from coalfields and will consequently be small for neighbouring towns. The residuals for such towns do not seem to show much correlation, however.

1.5.2. The possibility of using family budgets as an additional source of information on the influence of income on electricity consumption was carefully investigated, especially as the 1937-38 Ministry of Labour Working Class Inquiry and the 1938-39 Civil Service Research Bureau Middle Class Inquiry (cf. Massey (1942)) cover comparable periods. The principal difficulty was that in these budgets electricity consumption was not classified by tariff type but

* It should be remembered here that towns with a small number of two-part consumers were excluded (cf. 1.2.3).

by conditions of payment, viz., into prepayment and "other" consumption. Although it is certain that most "other" (i.e., credit) consumers have a two-part tariff, and conversely, the results from the family budgets are not strictly comparable with those from the 42 towns. Another point to be noted is that the budgets do not give total family income but only total expenditure (and for the Massey budgets also the income of the head of the household, but this has not been used here).

1.5.3. Comparable results are most likely to be obtained by combining the working class and the civil service budgets, since the population so obtained bears more resemblance to the total population than if the two were taken separately. The budgets considered belonged to two randomly selected subsamples of 533 working class and 274 middle class families respectively. Of these, 200 and 247 reported expenditure on electricity on credit (the figures refer to quarterly bills); other families were left out. The following regression equation was calculated from the individual budgets

$$y = \cdot 00622 (\pm \cdot 00057) E + 1 \cdot 776 \quad (R = \cdot 461) \quad (7)$$

where y = expenditure (including fixed charge, if any) on electricity (credit) and E = total expenditure on all items, both in £ per year. In order to compare this with the regional analysis we have correlated the average total outlay on electricity by two-part tariff consumers with M for the 42 towns; in the same units we get

$$y = \cdot 00691 (\pm \cdot 00083) M + 1 \cdot 094 \quad (R = \cdot 798) \quad (9)$$

It depends on the consumption function (i.e., the relation between E and M), on which no estimates are available, how consistent (7) and (9) are; it would appear that the income elasticity of x with respect to M is somewhat less when calculated from the family budgets than when calculated from the towns. As has been pointed out already these two analyses are not entirely comparable however.

1.6.0. In 1.2.1 we have discussed some obstacles to the application of time-series analysis to electricity demand, but it is interesting to see what one can achieve by that method.* Domestic electricity consumption (on all tariffs) in the period 1920–38 was correlated with the income of electricity consumers† and with the average price of electricity per kWh divided by the general price level. First differences were taken throughout, so as to eliminate serial correlation. The coefficient of income was not estimated from the time series but from the two family budget surveys mentioned in 1.5.2. The resultant equation was

$$\log \dot{X} = \cdot 89 \log Y - \cdot 61 (\pm \cdot 09) \log p/\pi + \cdot 045 (\pm \cdot 004)t \quad (10)$$

where X is domestic electricity consumption per consumer, Y the calculated average income of domestic electricity consumers, p/π the average price of domestic electricity divided by the general price level, and t a trend factor indicating that demand increased by 4.5 per cent. per annum. There is unfortunately no simple way of comparing the elasticity with respect to the average price given by (10) and the corresponding figure for the marginal price as given by (6).

1.6.1. Attempts were also made to apply a geographical analysis for 1937–38 to domestic consumption on flat rates, including special rates for heating and cooking. For a variety of reasons these attempts remained unsuccessful. The Electricity Commissioners' returns did not specify consumption and number of consumers on heating and cooking rates separately, although this demand is clearly of a different nature from demand on the lighting rate. Moreover, according to assumptions similar to those in 1.0.1 there was little variation in income between towns and finally the predetermined variables proved too highly intercorrelated. The resulting estimates were therefore too unreliable to be reproduced here.

* These results are due to Mr. J. R. N. Stone, who has kindly allowed me to publish them here.

† Calculated on the assumption that they are families with the highest incomes (cf 1.0.1). A correlation with total national income proved completely useless.

1951]

2. Monthly Variations in Electricity Generation, 1927-1944

2.0. In connection with the original project mentioned at the beginning of this paper an investigation of seasonal variations was undertaken. The basic data were monthly figures of total electricity generation (i.e., consumption of all kinds plus current lost in transmission) given in the *Twenty-third and Final Report of the Electricity Commissioners* (H.M.S.O., 1950, p. 54) for the period March, 1927-January, 1948 (post-war data were not used here because of the 1947 fuel crisis and similar disturbances). The purpose of the following calculations was to explain seasonal variations in terms of predetermined variables. Since the economic variables used in the first part of this inquiry do not show seasonal variations of any importance it was clear that these explanatory factors had to be non-economic. Temperature and day-light were the obvious variables to consider.

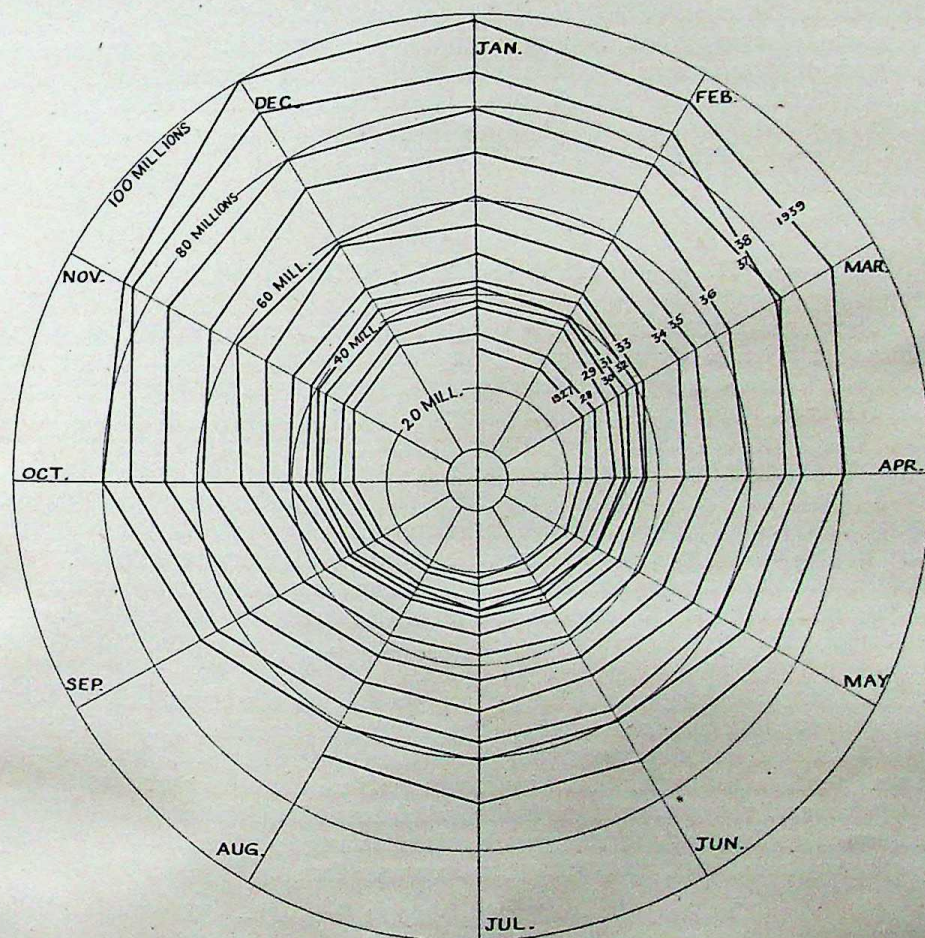


FIG. 1.—Electricity Generation, January, 1927–August, 1939. Number of kWh generated in Great Britain, per working day in each month.

2.1. The analysis was carried out by means of moving averages with a twelve-month period (more exactly: a weighted thirteen-month moving average). This method has sometimes been regarded with suspicion (e.g., by Spencer-Smith (1947)), chiefly because it may produce spurious oscillations in a non-oscillatory series. Mr. Spencer-Smith states, however, that "the method may be applicable in certain series in which the terms show a general upward or downward tendency, but even in this case the residual series should be viewed with suspicion unless there is other evidence about them" (p. 113). Both these conditions are satisfied here: the series shows

a strong upward tendency (cf. also 1.6.0) and the explanation in terms of temperature and daylight (cf. 2.2) provides additional evidence. It would certainly have been better to explain the trend instead of eliminating it, but unfortunately its shape was rather intractable mathematically.

2.2. The analysis was done separately for the period January, 1927–August, 1939 and for September, 1939–April, 1945 (at both ends of each series six months were lost by averaging). The data for the first period are represented in the diagram, from which a persistent seasonal pattern can easily be detected (generation increases geometrically, roughly speaking, and the seasonal pattern is multiplicative; when using a linear scale for the radii the successive tangents for each value of the angle are more or less parallel). For the calculations the differences between the logarithms of the monthly generation figures and the logarithm of their moving average were considered, with a correction for the number of working days (Saturdays were counted as $\frac{3}{4}$ and Sundays as $\frac{1}{2}$). Differences of moving averages were also used for the temperature series (derived from the *Statistical Abstract of the United Kingdom* and the *Annual Abstract of Statistics*), as fluctuations with a longer period than one year appeared to be present. Two multiple regressions were then made for the average deviation of all Januaries, all Februaries, etc., but excluding July and August because of holidays. The regression equations were for 1927–1939

$$z = -0.0134(\pm 0.0009)d - 0.00380(\pm 0.00038)t \quad (R = 0.9979) \quad (11)$$

and for 1940–44:

$$z = -0.00558(\pm 0.00016)d - 0.00299(\pm 0.00060)t \quad (R = 0.9987) \quad (12)$$

where the regression constants have been omitted. z is the average deviation of generation defined above; d is hours of daylight per day and t average temperature in degrees Fahrenheit for each month. The absolute magnitudes of these coefficients are of little interest, the remarkable features of (11) and (12) are the extremely high correlation coefficients, suggesting that the seasonal pattern can be perfectly explained by physical factors, and the differences between (11) and (12). It appears that during the war the importance of temperature and especially daylight in producing deviations from the moving average of generation was less important than before the war. Too much reliance should not be placed on this, however, for it appears also that during the war seasonal variations did not possess the remarkable regularity they showed in 1927–39, so that the high correlation in (12) may be accidental. Two further remarks are that according to bunch-map analyses neither (11) nor (12) are affected by multicollinearity and that in 1927–39 the average deviation for July also satisfied (11) very exactly, but that August showed a distinct drop due to holidays.

2.3. The influence of temperature in producing a long-term seasonal pattern for different months may well be different from its effect on generation in the same month of different years. Thus if one June is colder than another this may not cause any change in electric heating, but if it is unusually cold in November electricity demand will no doubt be stimulated. In order to test this separate analyses were made for the individual Januaries, Februaries, etc. The variables are again deviations from moving averages (logarithmic for generation, linear for temperature). The following regression coefficients for temperature were found:

October,	$-0.00380 (\pm 0.00071)$	$r = -0.877$
November,	$-0.00507 (\pm 0.00078)$	$r = -0.901$
December,	$-0.00339 (\pm 0.00105)$	$r = -0.751$
January,	$-0.00392 (\pm 0.00062)$	$r = -0.911$
February,	$-0.00546 (\pm 0.00064)$	$r = -0.950$
March,	$-0.00445 (\pm 0.00053)$	$r = -0.946$

For the other months the regression and correlation coefficients are all much smaller and not statistically significant. It appears that the influence of temperature on generation is greatest at the beginning and the end of winter, which is reasonable since (at any rate before the war) electricity was mainly used as an auxiliary form of heating. Probably more interesting results might have been obtained by considering the variability of temperature as distinct from its level. The

1951]

relatively low correlation coefficient for December arises from difficulties in allowing for the incidence of Christmas.

2.4. Finally, the very tentative nature of our investigations on seasonality should be stressed; it is hoped that the results here presented will encourage students of time series to a more detailed study of this valuable material (much work on these lines has no doubt been done by electricity undertakings for their own use).

References

- BARNA, T. (1945), *The Redistribution of Income through Public Finance in 1937*. Oxford Univ. Press.
- BOLTON, D. J. (1943), *Electricity Tariff Types*. London: Pitman.
- DE WOLFF, P. (1941), "Income-elasticity of demand, a micro-economic and a macro-economic interpretation", *Econ. J.*, **51**, 140.
- HOUTHAKKER, H. S. (1951), "Electricity tariffs in theory and practice", *Econ. J.*, **61**, 1.
- KOOPMANS, T. C. (1949), "Identification Problems in Economic Model Construction", *Econometrica*, **17**, 125.
- KOOPMANS, T. C., (Editor) (1950), *Statistical Inference in Dynamic Economic Models*, Cowles Commission Monograph No. 10. New York: Wiley. London: Chapman & Hall.
- MASSEY, P. (1942), "The expenditure of 1,360 British middle-class households in 1938-9", *J.R. Statist. Soc.*, **105**, 159.
- SPENCER-SMITH, J. L. (1947), "The oscillatory properties of the moving average", *J.R. Statist. Soc. Suppl.*, **9**, 104.
- TOBIN, J. (1950), "A statistical demand function for food in the U.S.A.", *J.R. Statist. Soc.*, **A. 113**, 113.

BIBLIOGRAPHY OF APPLICATIONS OF MATHEMATICAL STATISTICS TO ECONOMICS, 1943-1949

By A. D. SCOTT

	PAGE
I. Introduction	372
II. The Classification Systems	373
III. Bibliography	374
IV. Economic Classification	389
V. Mathematical-statistical Classification	392

I. Introduction

THIS bibliography of applications of mathematical statistics to economics has been prepared under the direction of a committee of the Department of Applied Economics, Cambridge, consisting of Richard Stone (chairman), H. S. Houthakker, James Tobin, J. E. G. Utting and G. S. Watson. Suggestions and assistance have also been received from other members of the Department's staff, the Marshall Library, the British Library of Political and Economic Science and a number of correspondents in other countries, including D. Cochrane, University of Melbourne; R. Derymaeker, Institut National des Statistiques, Brussels; M. R. Fisher, Auckland University College; G. Fürst, Statistisches Amt des Vereinigten Wirtschaftsgebietes, Wiesbaden; Professor D. R. Gadgil, Gokhale Institute of Politics and Economics, Poona; A. D. Guerreiro, Instituto Nacional de Estatística, Lisbon; G. Th. Guilbaud, Institut de Science Économique Appliquée, Paris; Professor T. Haavelmo, University Institute of Economics, Oslo; Professor A. Hald, Department of Economics, University of Copenhagen; H. D. Huggins, University College of the West Indies, Jamaica; E. John, Österreichisches Institut für Wirtschaftsforschung, Vienna; H. Kellerer, Institut für Wirtschaftsforschung, Munich; Professor J. Kingston, University of Brazil, Rio de Janeiro; H. Langelütke, Institut für Wirtschaftsforschung, Munich; E. H. Laurila, Central Statistical Office, Helsinki; M. Mukherjee, National Income Unit, Ministry of Finance, New Delhi; Professor Piatier, Institut National de la Statistique et des Études Économiques, Paris; H. Rijken van Olst, Netherlands Central Bureau of Statistics, The Hague; Professor R. Roy, École des Ponts et Chaussées, Paris; Professor E. Schneider, Neue Universität, Kiel; S. C. Sen, Indian Statistical Institute, Calcutta; L. Törnqvist, University of Helsinki; Professor H. O. A. Wold, Statistiska Institutionen, Uppsala University; U. Zwingli, Bureau Fédéral de Statistique, Berne. The assistance of Mrs. V. J. Stacy and Mrs. M. A. Cosgrove in tracing periodicals and in arranging, checking and typing the entries is also gratefully acknowledged.

Most of the articles listed in the bibliography have been seen before being classified; but a number of the titles suggested by correspondents abroad and a few which were taken from authors' footnotes and bibliographies were not readily available, and were classified on the basis of the information obtained from those sources.

The determination of what is, and what is not, an economic application of mathematical statistics has turned on whether the author has applied a method involving stochastic considerations to the analysis of genuine economic data in order to obtain results of economic significance. The use of mathematics in general economic theory has therefore been excluded as being neither applied to actual data, nor requiring consideration of stochastic problems. Although it has been necessary to apply the criterion rather loosely in some cases, there has been a consistent intention to exclude simpler techniques such as graphical illustration and free-hand curve fitting; and to include all applications of sampling theory, correlation, graduation, variance analysis, and the more advanced methods such as simultaneous and autoregressive equations.

In section III the papers have been listed in alphabetical order of the author's name, and given serial numbers, which have been used in the system of classification in sections IV and V. Section IV sets out thirteen general economic applications, subdivided into more specialized phases of the subject, and under each have been listed the serial numbers of the appropriate

articles. (The serial numbers in parentheses refer to articles which concentrate on the exposition of technique and theory rather than on actual application.) Section V classifies each article according to the mathematical-statistical method used, so that each article can be found by author, by economic subject, and by statistical method. The classification scheme is summarized below.

II. The Classification Systems

Economic Classification

1. Collection of Data Concerning Micro-economic Behaviour.

- (a) Family budget surveys.
- (b) Surveys of other economic units.

2. Estimation of Size Distributions.

- (a) Income.
- (b) Wealth.
- (c) Consumption.
- (d) Production.
- (e) Taxes.

3. Estimation of Social Accounting Aggregates.

- (a) Income.
- (b) Wealth.
- (c) Consumption.
- (d) Production.
- (e) Taxes.

4. Graduation, Reliability and Adjustment of Economic Data.

- (a) Income.
- (b) Wealth.
- (c) Consumption.
- (d) Production.
- (e) Taxes.

5. Demand Functions.

- (a) Consumers' goods:
 - (i) Consumption as a whole.
 - (ii) Particular goods.
- (b) Producers' goods.
- (c) Imports and exports.
- (d) Money and other assets: debts.

6. Production, Cost and Supply Functions.

- (a) Individual firms and industries:
 - (i) Agriculture.
 - (ii) Other industries.
 - (iii) National or whole economy functions.
- (b) Labour supply.
- (c) Business size, profitability; number of firms.
- (d) Inter-industry input-output relationships.

7. *Models of Particular Markets.*

- (a) Consumers' goods markets.
- (b) Producers' goods markets:
 - (i) Agriculture.
 - (ii) Other.
- (c) Labour markets.
- (d) International markets.
- (e) Financial markets.
- (f) Market structure and price determination.
- (g) Economic growth patterns.

8. *Explanations of Distribution of Incomes.*

- (a) Functional.
- (b) Industrial.
- (c) Regional.
- (d) Business financial policy.

9. *Interrelations between Government and the Economy.*10. *Business Cycle Models.*11. *Other Economic Relationships.*12. *Index Numbers.*13. *Theoretical and Expository Articles on the Application of Mathematical Statistics to Economics.*

Mathematical-Statistical Classification

21. *Measurement of Economic Magnitudes by Sampling Methods.*22. *Subjective Assessment of Errors of Observation and their Use in the Adjustment of Observations.*23. *Specification of Frequency Distributions of Economic Variables.*24. *Testing Hypotheses Concerning Economic Relationships, Estimation of Parameters and Prediction.*

- (a) Analyses of variance and co-variance.
- (b) Other applications of classical regression.
- (c) Confluence analysis.
- (d) Simultaneous equations.
- (e) Autoregressive single equations.
- (f) Other models.

III. *Bibliography*

1. ABREU, L. S. DE (1949), "Sondagens no domínio do rendimento nacional. O rendimento e o imposto", *Revista de Economia*, 2, 217-51.
2. ADELMAN, M. A. (1946), "Correlations and forecasting", *Amer. Econ. Rev.*, 36, 645-50.
3. ADLER, J. H. (1945), "United States import demand during the inter-war period", *Amer. Econ. Rev.*, 35, 418-30.
4. ADLER, J. H. (1946), "The post-war demand for United States exports", *Rev. Econ. Statist.*, 28, 23-33.
5. ADY, P. (1949), "Trends in cocoa production", *Bull. Oxf. Inst. Statist.*, 11, 389-404.
6. ÅKERMAN, J. (1948), "L'analyse structurelle des variations économiques", *Bulletin de l'institut de recherches économiques et sociales*, 14, 505-23.
7. ÅKERMAN, J. (1949), "Structural limits in economic development", *De Economist*, 97, 785-98.

1951]

8. ÅKERMAN, J. (1949), "Strukturgränser i svensk industrialism", *Ekon. Tidskr.*, 51, 1-18.
9. ÅKERMAN, J. et al. (1947 & 1948), "Ekonomi och politik", *Ekon. Tidskr.*, 49, 239-54, and 50, 18-28.
10. ALARCÃO, J. (1948), "Alguns princípios da investigação quantitativa em ciências sociais. Inferência e estimação estatística", *Revista de Economia*, 1, 92-8.
11. AMATO, V. (1948), "Sulla misura della concentrazione dei redditi", *Riv. Ital. Demog. Statist.*, 2, 504.
12. ANDERSON, O. (1949), "Mehr Vorsicht mit Indexzahlen", *Allg. Statist. Arch.*, 33, 472-9.
13. ANDERSON, O. (1949), "Über die repräsentative Methode und deren Anwendung auf die Aufarbeitung der Ergebnisse der bulgarischen landwirtschaftlichen Betriebszählung ...", *Herausgegeben vom Fachausschuss für Stichprobenverfahren der Deutschen Statistischen Gesellschaft, München*.
14. ANDERSON O., jr. (1949), "Die Saisonschwankungen in der Deutschen Stromproduktion vor und nach dem Kriege", *Schriftenreihe des Inst. für Wirts. München*, No. 6.
15. ANDERSON, R. L. (1947), "Use of variance components in the analysis of hog prices in two markets", *J. Amer. Statist. Ass.*, 42, 612-34.
16. ATKINSON, L. J. (1945), "The marginal feed cost of pork and lard", *J. Farm Econ.*, 27, 375-87.
17. ATKINSON, L. J. (1947), "Developments in the textile and apparel industries", *Surv. Curr. Bus.*, 27, No. 5, 14-20.
18. ATKINSON, L. J. (1948 & 1949), "Backlog demand for consumers' durable goods", *Surv. Curr. Bus.*, 28, No. 4, 15-21, and 29, No. 4, 3-6.
19. BARNA, T. (1945), *Redistribution of Incomes through Public Finance in 1937*. Oxford: Clarendon Press.
20. BARTLETT, M. S. (1948), "A note on the statistical estimation of supply and demand relations from time series", *Econometrica*, 16, 323-9.
21. BASSIE, V. L. (1946), "Consumers' expenditures in war and transition", *Rev. Econ. Statist.*, 18, 117-30.
22. BASSIE, V. L. (1948), "Woytinsky on consumption and savings", *Rev. Econ. Statist.*, 30, 298-300.
23. BATICLE, E. (1946), "Le problème des stocks", *J. Soc. Statist. Paris*, 87, 100-9.
24. BATSON, E. (1943), "A contribution to the study of relative roles of income levels and purchasing habits in the determination of sub-standard food consumption", *S. Afr. J. Econ.*, 11, 106-20.
25. BATSON, E. (1944), "The use of random sampling in sociographical research", *S. Afr. J. Econ.*, 12, 46-56.
26. BATTARA, P. (1949), "Dinamica della concentrazione nella industria elettrica", *L'industria*, 562-71.
27. BAUHAN, A. E. (1948), "Simulated plant-record method of life analysis of utility plant for depreciation-accounting purposes", *J. Land Pub. Util. Econ.*, 24, 129-36.
28. BEAN, L. H. (1946), "International industrialization and per capita income", *Studies in Income and Wealth*, 8. New York: National Bureau of Economic Research, 119-43.
29. BEAN, L. H. (1946), "Relation of disposable income and the business cycle to expenditures", *Rev. Econ. Statist.*, 28, 199-207.
30. BELLAMY, R. (1946), "The changing pattern of retail distribution", *Bull. Oxf. Inst. Statist.*, 8, 237-60.
31. BENNETT, R. F. (1943), "Significance of international comparisons in national income", *Studies in Income and Wealth*, 6. New York: National Bureau of Economic Research, 141-68.
32. BENNION, E. G. (1946), "The consumption function: cyclically variable?", *Rev. Econ. Statist.*, 28, 219-24.
33. BENSON, C. B. & KIMBALL, B. F. (1945), "Mortality characteristics of physical property based upon location life table and re-use ratios", *Econometrica*, 13, 214-24.
34. BENTZEL, R. & WOLD, H. (1946), "On statistical demand analysis from the viewpoint of simultaneous equations", *Skand. Aktuariatidskr.*, 29, 95-114.
35. BLACK, J. D. (1946), "National income and farm income", *J. Farm Econ.*, 28, 560-2.
36. BLACK, J. D. (1946), "The income elasticity of milk", *J. Farm Econ.*, 18, 845-8.
37. BLACK, W. E. (1943), *Consumer Demand for Apples and Oranges*. New York: Cornell Sta. Bull. No. 800.
38. BLAKEY, R. G. et al. (1944), *Analyses of Minnesota Incomes, 1938-39*, *Studies in Economics and Business*, No. 14. Minneapolis: University of Minnesota.
39. BLONDEL, F. (1949), "Note sur la répartition géographique de la production minérale", *J. Soc. Statist. Paris*, 90, 372-82.
40. BOLZA, H. (1947), *Grundriss einer systematischen Wirtschaftslehre*, Vol. 1, 2nd ed. Stuttgart: W. Kohlhammer.
41. BONIFACIO, G. (1948), "Sulla correlazione fra reddito e taluni consumi alimentari", *Riv. Ital. Demog. Statist.*, 2, 550-61.
42. BOSE, S. R. (1943), "Some investigations in banking currency and prices", *Indian J. Econ.*, 24, 20-37.
43. BOWEN, I. (1946), "The future output of the constructional industries in the United States", *Econ. J.*, 56, 208-29.
44. BOWER, P. A. (1949), *Balance of Payments of Nigeria in 1936*. Oxford: Blackwell.
45. BOWMAN, M. J. (1945), "A graphical analysis of personal income distribution in the United States", *Amer. Econ. Rev.*, 35, 605-28.
46. BOX, K. (1946), *The Cinema and the Public*, *The Social Survey*, N.S. No. 106. London: Central Office of Information.
47. BRADY, D. S. (1946), "Expenditures and savings of city families in 1944", *Mon. Lab. Rev.*, 62, 1-5.
48. BRADY, D. S. (1946), "Expenditures, savings, and income", *Rev. Econ. Statist.*, 28, 216-8.
49. BRADY, D. S. & BARBER, H. A. (1948), "The pattern of food expenditures", *Rev. Econ. Statist.*, 30, 198-206.

50. BRAMBILLA, F. (1947), "Nuovi metodi statistici per lo studio delle produzioni industriali", *L'industria*, 165-94.
51. BRAMBILLA, F. (1948), *Analisi Confluenziale*. Milan: Casa editrice ambrosiana.
52. BRAMBILLA, F. (1948), "Modelli stocastici in econometrica", *L'industria*, 148-76.
53. BRAMBILLA, F. (1949), "Ricerche attorno ai costi di produzione in taluni rami d'industria", *L'industria*, 538-41.
54. BRAMBILLA, F. (1949), "Un'applicazione econometrica della teoria della produzione all'industria del gas", *L'industria*, 255-8.
55. BRATT, E. C. & WILSON, D. S. (1943), "Regional distortions resulting from the war", *Surv. Curr. Bus.*, 23, No. 10, 9-15.
56. BRATT, E. C. *et al.* (1943), "Post-war sales territories", *Surv. Curr. Bus.*, 23, No. 12, 6-12.
57. BREIMYER, H. F. (1943), "The efficiency of feeding livestock", *J. Farm Econ.*, 25, 599-621.
58. BRESCIANI-TURRONI, C. (1949), "Recherches inductives sur la prévision des prix", *Metroeconomica*, 1, 5-29.
59. BREYER, R. F. (1946), "Some preliminary problems of sample design for a survey of retail trade flow", *J. Marketing*, 10, 343-53.
60. BROOKS, E. M. & SEIF, C. (1949), "A report on the general enumerative surveys", *Agric. Econ. Res.*, 1, 37-48 and 105-28.
61. BRONFENBRENNER, M. (1944), "Production functions: Cobb-Douglas, interfirm, intrafirm", *Econometrica*, 12, 35-44.
62. BRONFENBRENNER, M. (1948), "The consumption function controversy", *Sth. Econ. J.*, 14, 304-20.
63. BRONOWSKI, J. *et al.* (1949), "Some uses of statistics in the building industry: an investigation into the erection times of nine types of non-traditional house", *J.R. Statist. Soc.*, 112, 287-308.
64. BROWN, E. C. (1949), "Some evidence on business expectations", *Rev. Econ. Statist.*, 31, 236-8.
65. BROWNE, G. W. G. (1943), "The production function for South African manufacturing industry", *S. Afr. J. Econ.*, 11, 258-68.
66. BURNS, A. F. & MITCHELL, W. C. (1947), *Measuring Business Cycles*. New York: National Bureau of Economic Research.
67. BUTLER, R. (1946), "Growth patterns for new specialty products: a case study", *J. Marketing*, 11, 27-34.
68. CALLANDER, W. F. & SARLE, C. F. (1947), "The bureau of agricultural economics program in enumerative sampling", *J. Farm Econ.*, 29, 233-6.
69. CAMPBELL, G. C. (1948), "Problems with sampling procedures for reserve valuations", *J. Amer. Statist. Ass.*, 43, 413-27.
70. CAPT, J. C., *et al.* (1945), *A Chapter in Population Sampling*. Washington, D.C.: U.S. Dept. of Commerce, Bureau of Census.
71. CARTER, C. F. & CHANG, T. C. (1946), "A further note on the British balance of payments", *Economica*, 13, 183-9.
72. CASSADY, R., Jr. (1945), "Statistical sampling techniques and marketing research", *J. Marketing*, 9, 317-41.
73. CASTAÑEDA, J. (1945), *El consumo de tabaco en Espana y sus factores*. Madrid: Instituto de estudios politicos, and *Revista de Economia Politica*, 1.
74. CASTELLANO, V. (1949), "Vecchi e nuovi problemi nello studio delle distribuzioni dei redditi", *G. Econ. Ann. Econ.*, 8, n.s., 379-89.
75. CAVE, R. C. (1943), "Variations in expenditures where families of wage earners and clerical workers are classified by economic level", *J. Amer. Statist. Ass.*, 38, 445-52.
76. CAVIN, J. P. (1945), "Aspects of wartime consumption", *Amer. Econ. Rev.* (Proceedings, Feb., 1945), 35, 15-36.
77. CAVIN, J. P. (1949), *Consumption of Food in the United States, 1909-48*. Washington: U.S. Department of Agriculture Miscellaneous Publications, No. 691, August, 1949.
78. CHAMPERNOWNE, D. G. (1948), "Sampling theory applied to autoregressive sequences", *J.R. Statist. Soc.*, (B), 10, 204-42.
79. CHANG, T. C. (1945-46), "International comparison of demand for imports", *Rev. Econ. Stud.*, 13, 53-67.
80. CHANG, T. C. (1946), "The British demand for imports in the inter-war period", *Econ. J.*, 56, 188-207.
81. CHANG, T. C. (1947), "The British balance of payments, 1924-1938", *Econ. J.*, 57, 473-503.
82. CHANG, T. C. (1947), "A note on exports and national income in Canada", *Canad. J. Econ. Pol. Sci.*, 13, 276-80.
83. CHANG, T. C. (1948), "A statistical note on world demand for exports", *Rev. Econ. Statist.*, 30, 106-16.
84. CHATTERJEE, T. P. (1947), "On the general law of demand for raw jute", *Sankhyā*, 8, 271-4.
85. CHATURVEDI, H. K. & BHATTACHERYYA, S. (1948), "On the change in standard of living of the jute mill workers of Jagaddal between the years 1941 and 1945", *Sankhyā*, 8, 360-71.
86. CHENERY, H. B. (1949), "Engineering production functions", *Q. J. Econ.*, 63, 507-31.
87. CHUDSON, W. A. (1945), *The Pattern of Corporate Financial Structure*. New York: National Bureau of Economic Research.
88. CHURCH, D. E. (1949), "Survey of transportation from farms to initial markets", *Agric. Econ. Res.*, 1, 48-51.
89. CHURCHILL, B. C. & FOSS, M. F. (1949), "State estimates of the business population", *Surv. Curr. Bus.*, 29, No. 12, 8-15.

1951]

90. CHURCHMAN, C. W. *et al.* (1947), *Measurement of Consumer Interest*. Philadelphia: University of Pennsylvania Press.
91. CLARK, C. G. (1945), "Post-war savings in the U.S.A.", *Bull. Oxf. Inst. Statist.*, 7, 97-103.
92. CLARK, C. G. (1949), "A system of equations explaining the United States trade cycle, 1921 to 1941", *Econometrica*, 17, 93-124.
93. CLARK, C. G. (1949), "The productivity of industry", *Rev. Econ. Progr.*, 1, Nos. 6-11.
94. CLARK, C. G. (1949), "The value of the pound", *Econ. J.*, 59, 198-207.
95. CLARK, E. & FISHMAN, L. (1947), "Appraisal of methods for estimating the size distribution of a given aggregate income", *Rev. Econ. Statist.*, 29, 43-6.
96. CLAWSON, M. (1943), "Demand interrelations for selected agricultural products", *Q. J. Econ.*, 57, 265-302.
97. CLAWSON, M. (1946), "Cattle-hog price and beef-pork consumption ratio", *J. Farm Econ.*, 28, 848-52.
98. COBB, C. W. (1943), "A regression", *Econometrica*, 11, 265-7.
99. COCHRANE, D. (1949), "Measurement of economic relationships", *Econ. Rec.*, 25, 7-23.
100. COCHRANE, D. & ORCUTT, G. H. (1949), "Application of least squares regression to relationships containing autocorrelated error terms", *J. Amer. Statist. Ass.*, 44, 32-61.
101. COCHRANE, W. W. (1947), "Farm family budgets—a moving picture", *Rev. Econ. Statist.*, 29, 189-98.
102. COCHRANE, W. W. (1947), "Farm price gyrations—an aggregative hypothesis", *J. Farm Econ.*, 29, 383-408.
103. COCKFIELD, F. A. (1947), "The distribution of incomes", *Economica*, 14, 254-82.
104. COONEY, E. W. (1949), "Capital exports, and investment in building in Britain and the U.S.A., 1856-1914", *Economica*, 16, 347-54.
105. COOPER, G. (1948), "The role of econometric models in economic research", *J. Farm Econ.*, 30, 101-16, and Cowles Commission Paper, N.S., No. 27.
106. CORBIAU, P.-E. (1947), "La fonction logistique et la description des phénomènes de développement économiques et sociaux", *Bulletin de l'institut de recherches économiques et sociales*, 13, 41-91.
107. CORNFIELD, J. *et al.* (1947), "Full employment patterns, 1950", parts 1 and 2, *Mon. Lab. Rev.*, 64, 163-90 and 420-32.
108. COWLES, A. (1944), "Stock market forecasting", *Econometrica*, 12, 206-14.
109. CUSIMANO, G. (1948), "Sull'analisi della varianza", *Ann. Fac. Econ. Comm. Palermo*, 2, 49-91.
110. D'ADDARIO, R. (1949), "Ricerca sulla curva dei redditi", *G. Econ. Ann. Econ.*, 8, N.S., 91-114.
111. DALENIUS, T. (1949), *Om Stickprovsundersökningens teknik och metodik*. Stockholm: Förlags AB Affärsökonomi. *Technik und Methode der Stichprobenerhebungen*, Schriftenreihe des Fachauschusses für Stichprobenverfahren der Deutschen Statistischen Gesellschaft, Munich, Vol. 2, January, 1950.
112. DALMULDER, J. J. J. (1948), "De functie van de econometrie bij het bedrijfsbeheer", *Statistica* (The Hague), 2, 2-18.
113. DALMULDER, J. J. J. (1949), *Het verband tussen de bevolking, het nationale inkomen en de kapitaal-goederenvoorraad*. Utrecht: Uitgeverij Het Spectrum.
114. DALY, P. *et al.* (1943), "The production function for manufacturing in the United States", *J. Pol. Econ.*, 51, 61-5.
115. D'AMORE, F. (1948), "Variazioni dinamiche del grado di liquidità nel sistema industriale", *Riv. Ital. Demog. Statist.*, 2, 562-81.
116. DAYRE, J. (1945), "Essai sur le foisonnement des stocks dans l'économie concurrentielle", *J. Soc. Statist. Paris*, 86, 122-30.
117. DEAN, J. (1949), "Cost forecasting and price policy", *J. Marketing*, 13, 279-88.
118. DEAN, J. & JAMES, R. W. (1943), *The Long-run Behavior of Costs in a Chain of Shoe Stores: A Statistical Analysis*, Studies in Business Administration, 13, 3. Chicago: University of Chicago Press.
119. DEMING, W. E. (1947), "Some criteria for judging the quality of surveys", *J. Marketing*, 12, 145-57.
120. DEMING, W. E. & SIMMONS, W. (1946), "On the design of a sample for dealers' inventories", *J. Amer. Statist. Ass.*, 41, 16-33.
121. DEMPSEY, B. W. (1943), "Cyclical variations in income distributions", *Econometrica*, 11, 168-9.
122. DENISON, E. F. (1945), "Service industries—trends and prospects", *Surv. Curr. Bus.*, 25, No. 1, 11-20.
123. DEREYMAEKER, R. (1948), "Étude statistique mathématique sur l'indice des prix de détail", *Bulletin de Statistique—Institut National de Statistique* (Belgium), 34.
124. DERKSEN, J. B. D. (1944), "Statistische berekeningen over de veideling der gezinsinkomens", *Maandschrift van het Centraal Bureau van de statistiek*, 39, 287-96.
125. DESAI, R. C. (1948), "Consumer expenditure in India, 1931-2 to 1940-1", *J.R. Statist. Soc.*, 111, 261-307.
126. DE VERGOTTINI, M. (1947), "Sulla relazione tra gli Indici Alfa e Delta", *G. Econ. Ann. Econ. Milan*, 6, N.S., 56-60.
127. DEWHURST, J. F. *et al.* (1947), *America's Needs and Resources*. New York: The Twentieth Century Fund.
128. DIENA, L. (1949), "Cenni sulla propensione all'importazione", *G. Econ. Ann. Econ. Milan*, 8, N.S., 390-409.
129. DOBLIN, E. M. (1949), "The ratio of income to money supply". International Association for Research in Income and Wealth, paper No. 15, Cambridge (mimeo.).

130. DONNAHOE, A. S. (1947), "Measuring state tax burden", *J. Pol. Econ.*, 55, 234-44.
131. DOR, L. (1948), "Analyse des phénomènes logistiques à l'aide de la courbe normale intégrale", *Bulletin de l'institut de recherches économiques et sociales*, 14, 597-621.
132. DOR, L. (1948), "Économie et probabilité", *Bulletin technique de la société royale belge des ingénieurs et des industriels*, A, No. 5, 261-7.
133. DOUGLAS, P. H. (1948), "Are there laws of production?", *Amer. Econ. Rev.*, 38, 1-41.
134. DOUGLAS, P. H. & DALY, P. (1943), "The production function for Canadian manufactures", *J. Amer. Statist. Ass.*, 38, 178-86.
135. DOWELL, A. A. & ENGELMAN, G. (1949), "Research into the problems involved in marketing slaughter livestock by carcass weight and grade", *J. Farm Econ.*, 31, 343-69.
136. DUCOFF, L. J. & BANCROFT, G. (1945), "Experiment in the measurement of unpaid family labor in agriculture", *J. Amer. Statist. Ass.*, 40, 205-13.
137. DUESENBERRY, J. S. (1948), "Income—consumption relations and their implications", *Income, Employment and Public Policy: Essays in Honor of Alvin H. Hansen*. New York: Norton, 54-81.
138. DUESENBERRY, J. S. (1949), *Income, Saving, and the Theory of Consumer Behavior*. Cambridge, Mass.: Harvard.
139. DUFRÉNOY, J. & M.-L. (1948), "La distribution des biens et des aptitudes", *J. Soc. Statist. Paris*, 89, 321-33.
140. DUMONTIER, J. (1949), "La comptabilité nationale et les corrélations", *Rev. Econ. Pol.*, 59, 479-96.
141. DUNCAN, A. J. (1946), "'Free money' of large manufacturing corporations and the rate of interest", *Econometrica*, 14, 251-3.
142. DUPRIEZ, L. (1945), "Une détermination statistique des pertes subies par la circulation métallique belge", *Bulletin d'Information et de Documentation—Banque Nationale de Belgique*, 20 (I), 1-14.
143. DURAND, — (1948), *La demande d'allumettes en France de 1890 à 1943*, Thèse Inst. de Statist. de Paris.
144. DURAND, D. (1943), "A simple method for estimating the size distribution of a given aggregate income", *Rev. Econ. Statist.*, 25, 227-30.
145. DURAND, D. (1948), "An appraisal of the errors involved in estimating the size distribution of a given aggregate income", *Rev. Econ. Statist.*, 30, 63-8.
146. DURANT, H. & GOLDMAN, J. (1945), "The distribution of working-class savings", *Bull. Oxf. Inst. Statist.*, 7, 1-7.
147. DÜTSCHLER, H. (1945), "Eine statistische Verifikation der Bernoullischen Hypothese über die Grenznutzenfunktion des Geldes", *Schweiz. Z. Volksw. Statist.*, 81, 175.
148. EDWARDS, F. K. (1947), "Cost analysis in transportation", *Amer. Econ. Rev.*, 37, 441-61.
149. EINARSEN, J. (1946), "Replacement in the shipping industry", *Rev. Econ. Statist.*, 28, 225.
150. ELLIS, A. W. T. (1944), "Rents, rates and income in Bristol", *Rev. Econ. Stud.*, 11, 99-108.
151. EPSTEIN, J. B. (1949), "Electric power output and investment", *Surv. Curr. Bus.*, 29, No. 5, 11.
152. EPSTEIN, L. A. *et al.* (1945 & 1946), "Wartime food purchases", *Mon. Lab. Rev.*, 61 and 62, 175-80, and (1945), U.S. Bureau of Labor Statistics, Bulletin No. 838.
153. ERICSON, O. (1945), "Un problème de la répartition des revenus", *Skand AktuarTidskr.*, 28, 245-57.
154. EUGENE, S. A. (1943), "New light on factor analysis", *J. Farm Econ.*, 25, 477-86.
155. EZEKIEL, M. (1943), "Choice of the dependent variable in regression analysis—comments", *J. Amer. Statist. Ass.*, 38, 214-16.
156. EZEKIEL, M. (1944), "The statistical determination of the investment schedule", *Econometrica*, 12, 89-90.
157. FEIN, E. (1947), "Zur modelltechnik—Anwendung betriebswirtschaftlicher Methoden auf national-ökonomische Probleme", *Schweiz. Z. Volksw. Statist.*, 83, 30-60.
158. FINKER, A. L. *et al.* (1943), "Methods of estimating farm employment from sample data in North Carolina", *North Carolina Sta. Tech. Bull.*, 75.
159. FLAUS, L. (1949), "Les fluctuations de la construction d'habitations urbaines", *J. Soc. Statist. Paris*, 90, 185-222.
160. FLORENCE, P. S. & BALDAMUS, W. (1948), *Investment, Location, and Size of Plant*. Cambridge: University Press.
161. FOGARTY, M. P. (1943), "The incidence of rates on houses", *Rev. Econ. Stud.*, 10, 81-105.
162. FORSTER, G. W. (1944), "Some defects in the analysis of farm management data", *J. Farm Econ.*, 26, 775-9.
163. FORSTER, G. W. (1946), "Southern agricultural economy in the postwar era", *Sth. Econ. J.*, 13, 65-71.
164. FOUGSTEDT, G. (1948), "Inkomstens fördelning i Finland", *Ekonomiska Samsfundets Tidskrift*, 1, 248-73.
165. FRANKEL, S. H. & HERZFELD, H. (1943), "European income distribution in the Union of South Africa and the effect thereon of income taxation", *S. Afr. J. Econ.*, 11, 121-36.
166. FRÉCHET, M. (1945), "Nouveaux essais d'explication de la répartition des revenus", *Rev. Inst. Int. Stat.*, 13, 16-32.
167. FRÉCHET, M. (1947), "Anciens et nouveaux indices de corrélation. Leur application au calcul des retards économiques", *Econometrica*, 15, 1-30, and Errata, 15, 374-5.
168. FRIDAY, F. A. (1946), "United Kingdom export target", *Bull. Oxf. Inst. Statist.*, 8, 169-77.
169. FRIEND, I. (1944), "Individuals' demand deposits, June, 1942-43", *Surv. Curr. Bus.*, 26, No. 6, 14-22.
170. FRIEND, I. (1946), "Relationship between consumers' expenditures, savings, and disposable income", *Rev. Econ. Statist.*, 28, 208-15.
171. FRIEND, I. (1949), "Personal saving in the postwar period", *Surv. Curr. Bus.*, 29, No. 9, 9-17, and 23.

1951]

172. FRISCH, R. (1949), "Uno studio di R. Frisch sulla politica dei prezzi, salari, tassazione e sussidi come strumenti per mantenere l'occupazione totale", *L'industria*, 572-88.
173. FURLAN, L. V. (1946), "Iterierte konzentration", *Schweiz. Z. Volksw. Statist.*, 82, 1-21.
174. FURLAN, L. V. (1949), "Iterierte konzentration", *Schweiz. Z. Volksw. Statist.*, 85, 291-5.
175. GADGIL, D. R. (1948), *Economic Effects of Irrigation*. Poona: Gokhale Institute of Politics and Economics.
176. GADGIL, D. R. *et al.* (1945), *Poona: A Socio-economic Survey. Part I—Economic*. Poona: Gokhale Institute of Politics and Economics.
177. GARNIER, J. & BRICHLER, M. (1946), "Études de la demande" Direction de la statistique générale, ministère de l'économie nationale, *Études théoriques*, No. 2, 5-61.
178. GARVY, G. (1944), "Dr. Rhodes' analysis of the distribution of single incomes in the United States", *Economica*, 11, 104-5.
179. GARVY, G. (1948), "The role of dissaving in economic analysis", *J. Pol. Econ.*, 56, 416-27.
180. GEARY, R. C. (1948), "Studies in relations between economic time series", *J.R. Statist. Soc.*, (B), 10, 140-58.
181. GEARY, R. C. (1949), "Determination of linear relations between systematic parts of variables with errors of observation the variances of which are unknown", *Econometrica*, 17, 30-58.
182. GEREN, P. (1943), "The contribution of life insurance to the savings stream", *J. Pol. Econ.*, 51, 33-51.
183. GIACCARDI, F. (1949), "Sulla curva dei redditi", *G. Econ. Ann. Econ. Milan*, 8, n.s., 115-21.
184. GIFFEN, R. R. (1947), "Changing output per person employed in trade, 1900 to 1940", *J. Marketing*, 12, 242-5.
185. GIRSHICK, M. A. & HAAVELMO, T. (1947), "Statistical analysis of the demand for food: examples of simultaneous estimation of structural equations", *Econometrica*, 15, 79-110.
186. GOLD, N. L. & ENLOW, M. (1943), "The demand for food by low income families", *Q. J. Econ.*, 57, 596-629.
187. GOLDBERG, S. A. (1949), "The concept of disposable income: a reply", *Canad. J. Econ. Pol. Sci.*, 15, 539-42.
188. GOLDENWEISER, E. A. & HAGEN, E. E. (1944), "Jobs after the war", *Fed. Reserve Bull.*, 30, 424-31.
189. GOLDMANN, J. (1943), "Taxation of tobacco, beer, and cinema attendances", *Bull. Oxf. Inst. Statist.*, 5, 35-9.
190. GOLDMANN, J. (1944), "Expenditure on rent", *Bull. Oxf. Inst. Statist.*, 6, 173-8.
191. GOODMAN, R. (1947), "Sampling for the 1947 survey of consumer finances", *J. Amer. Statist. Ass.*, 42, 439-48.
192. GOULD, J. M. (1946), *Output and Productivity in the Electric and Gas Utilities, 1899-1942*. New York: National Bureau of Economic Research.
193. GRAAFF, J. DE V. (1946), "Fluctuations in income concentration", *S. Afr. J. Econ.*, 14, 22-39.
194. GUILBAUD, G. TH. (1949), "Note sur l'économétrie des fluctuations", *Econ. Appl.*, 2, 429-95.
195. GUITTON, H. (1946), "Offre et demande et débit", *Rev. Econ. Pol.*, 56, 135-77.
196. HAAVELMO, T. (1943), "The statistical implications of a system of simultaneous equations", *Econometrica*, 11, 1-12.
197. HAAVELMO, T. (1943), "Statistical testing of business-cycle theories", *Rev. Econ. Statist.*, 25, 13-8.
198. HAAVELMO, T. (1944), "The probability approach in econometrics", *Econometrica*, 12, supplement.
199. HAAVELMO, T. (1945), "Strukturrelasjoner og planøkonomi", *Statøkonomisk Tidsskrift*, 82.
200. HAAVELMO, T. (1947), "Family expenditures and the marginal propensity to consume", *Econometrica*, 15, 335-41.
201. HAAVELMO, T. (1947), "Methods of measuring the marginal propensity to consume", *J. Amer. Statist. Ass.*, 42, 105-22, and Cowles Commission paper No. 22, n.s.
202. HAAVELMO, T. (1947), "Quantitative research in agricultural economics", *J. Farm Econ.*, 29, 910, and Cowles Commission, No. 27, n.s.
203. HAGEN, E. E. (1945), "Postwar output in the United States at full employment", *Rev. Econ. Statist.*, 27, 45-59.
204. HAGEN, E. E. (1947), "The reconversion period: reflections of a forecaster", *Rev. Econ. Statist.*, 29, 95-101.
205. HAGEN, E. E. *et al.* (1947), "Forecasting gross national product and employment during the transition period: an example of the 'Nation's Budget' method", *Studies in Income and Wealth*, 10. New York: National Bureau of Economic Research, 94-130.
206. HALD, A. (1948), *The Decomposition of a Series of Observations Composed of a Trend, a Periodic Movement and a Stochastic Variable*. Copenhagen: G. E. C. Gads Forlag.
207. HANNA, F. A. (1948), "The accounting period and the distribution of income", *Studies in Income and Wealth*, 9. New York: National Bureau of Economic Research, 153-256.
208. HANNA, F. A. *et al.* (1948), "Analysis of Wisconsin income", *Studies in Income and Wealth*, 9. New York: National Bureau of Economic Research, 17-58.
209. HANSEN, M. H. & HURWITZ, W. N. (1943), "On the theory of sampling from finite populations", *Ann. Math. Statist.*, 14, 333-62.
210. HANSEN, M. H. & HURWITZ, W. N. (1949), "Dependable samples for market surveys", *J. Marketing*, 14, 363-72.
211. HANSEN, M. H. *et al.* (1946), "Problems and methods of the sample survey of business", *J. Amer. Statist. Ass.*, 41, 173-89.
212. HANSON, A. C. *et al.* (1945), *Family Spending and Saving in Wartime*. United States Dept. of Labor: Bureau of Labor Statistics, Bulletin No. 822.

213. HART, G. A. & LIEBLEIN, J. (1946), "Family income and the income tax base", *Studies in Income and Wealth*, 8. New York: National Bureau of Economic Research, 235-62.
214. HART, H. (1946), "Depression, war, and logistic trends", *Amer. J. Sociol.*, 52, 112-22, and (1945), *Logistic Social Trends*, 50, 337-52.
215. HARTKEMEIER, H. P. (1944), "Seasonal variation in the volume of bills discounted", *Econometrica*, 12, 125-9.
216. HASEL, A. A. & POLI, A. (1949), "A new approach to forest ownership surveys", *J. Land Pub. Util. Econ.*, 25, 1-10.
217. HAUSER, P. M. & HANSEN, M. H. (1944), "On sampling in market surveys", *J. Marketing*, 9, 26-31.
218. HAYES, S. P., Jr. (1948), "Commercial surveys as an aid in the determination of public policy: a case study", *J. Marketing*, 12, 475-82.
219. HEADLEY, F. B. & HARTLEY, M. L. (1944), "Relation of total income on farms to price index", *Farm Management (Nevada Sta.) Bull.*, No. 5.
220. HEADY, E. O. (1946), "Production functions from a random sample of farms", *J. Farm Econ.*, 28, 989-1004.
221. HENDERSON, A. (1948), "The cost of a family", *Man. Statist. Soc. Trans.*, 8, 1-33.
222. HENDERSON, A. (1949), "The cost of children", part 1, *Population Stud.*, 3, 130-50.
223. HENDRICKS, W. A. (1944), "The relative efficiencies of groups of farms as sampling units", *J. Amer. Statist. Ass.*, 39, 336-76.
224. HENDRICKS, W. A. (1947), "Farm employment levels in relation to supply and demand as per cent. of normal", *J. Amer. Statist. Ass.*, 42, 271-81.
225. HENDRICKS, W. A. (1949), "Adjustment for bias caused by non-response in mailed surveys", *Agric. Econ. Res.*, 1, 52-6.
226. HENON, R. (1943), "L'amortissement du matériel industriel", *J. Soc. Statist. Paris*, 84, 119-55.
227. HERLEMANN, H.-H. (1949), "Die einkommenselastizität des mineraldungsverbrauchs", *Wirtsch. Statist.*, 62, 242-74.
228. HERRMANN, L. F. (1943), "Diminishing returns in feeding commercial dairy herds", *J. Farm Econ.*, 25, 397-409.
229. HINSHAW, R. (1945), "American prosperity and the British balance-of-payments problem", *Rev. Econ. Statist.*, 27, 1-9.
230. HINSHAW, R. & METZLER, L. A. (1945), "World prosperity and the British balance of payments", *Rev. Econ. Statist.*, 27, 156-70.
231. HOLMES, I. (1943), "Some sampling uses of data from the census of agriculture", *J. Amer. Statist. Ass.*, 38, 78-86.
232. HOPE, R. (1949), "Profits in British industry from 1924 to 1935", *Oxf. Econ. Pap.*, 1, n.s., 159-81.
233. HORNER, F. B. (1949), "The demand equation for a raw material in empirical studies", *Econ. Rec.*, 25, 85-91.
234. HOUSEMAN, E. E. (1947), "The sample design for a national survey by the Bureau of Agricultural Economics", *J. Farm Econ.*, 29, 241-5.
235. HOUSEMAN, E. E. (1949), "Design of samples for surveys", *Agric. Econ. Res.*, 1, 3-10.
236. HOUTHAKKER, H. S. (1949), "Afzet en prijsvorming van electriciteit voor woningen", *De Economist*, 485-505.
237. HUBBACK, J. A. (1946), "Sampling for rice yield in Bihar and Orissa", *Sankhyā*, 7, 281-94.
238. HUMES, H. (1949), "Estimate of new unit bias in CPI rent index", *Mon. Lab. Rev.*, 69, 45-9.
239. HUMES, H. & SCHIRO, B. (1948 & 1949), "The rent index: concept and methodology", *Mon. Lab. Rev.*, 67, 631-9, and 68, 60-8.
240. HURWICZ, L. (1944), "Stochastic models of economic fluctuations", *Econometrica*, 12, 114-24.
241. HURWICZ, L. (1947), "Some problems arising in estimating economic relations", *Econometrica*, 15, 236-40.
242. HURWITZ, A. (1948), "D. C. family income in relation to BLS family budget", *Mon. Lab. Rev.*, 67, 622-3.
243. HYRENIUS, D. H. (1946), "The relation between birth rates and economic activity in Sweden, 1920-1944", *Bull. Oxf. Inst. Statist.*, 8, 14-22.
244. HYSON, C. D. (1947), "Maladjustments in the wool industry and need for a new policy", *J. Farm Econ.*, 29, 425-56.
245. HYSON, C. D. & SANDERSON, F. H. (1945), "Monopolistic discrimination in the cranberry industry", *Q. J. Econ.*, 59, 330-69.
246. JACOBS, W. W. & BROIDA, S. F. (1949), "Current inventory development", *Surv. Curr. Bus.*, 29, No. 4, 14.
247. JACQUEMYS, G. (1949), *Budgets familiaux d'ouvriers et d'employés 1947-1948*. Bruxelles: Institut universitaire d'information sociale et économique, No. 1.
248. JACQUEMYS, G. (1949), *La maison heureuse*. Bruxelles: Institut universitaire d'information sociale et économique, No. 3.
249. JACQUEMYS, G. (1949), *Vacances et congés payés des Belges*. Bruxelles: Institut universitaire d'information sociale et économique, No. 2.
250. JASTRAM, R. W. (1949), "Advertising ratios planned by large-scale advertisers", *J. Marketing*, 14, 13-21.
251. JESSEN, R. J. (1947), "The master sample project and its use in agricultural economics", *J. Farm Econ.*, 29, 531-40.

1951]

252. JESSEN, R. J. (1949), "Some inadequacies of the federal censuses of agriculture", *J. Amer. Statist. Ass.*, **44**, 279-92.
253. JESSEN, R. J. & HOUSEMAN, E. E. (1944), "Statistical investigations of farm sample surveys in Iowa, Florida, and California", *Iowa Sta. Res. Bull.*, No. 329, 261-338.
254. JOHNSON, D. G. (1948), "The use of econometric models in the study of agricultural policy", *J. Farm Econ.*, **30**, 117-30.
255. JOHNSON, H. A. & PAARLBERG, D. (1948), "A method of predicting numbers of hens and pullets on Indiana farms January 1", *J. Farm Econ.*, **30**, 713-23.
256. JOHNSON, R. H. (1946), "Variations in department store sales-expense ratios", *Surv. Curr. Bus.*, **26**, No. 9, 18-24.
257. JONES, H. L. (1946), "Note on square-root charts", *Econometrica*, **14**, 313-5.
258. JORGENSEN, H. C. (1945), "Tinbergens konjunkturanalyse", *Nat. Økon. Tidsskr.*, **83**, 260-74.
259. KAFURI, J. F. (1945), "A cooperação da estatística com a economia", *Rev. Brasileira Estatist.*, **6**, 393-410.
260. KALDOR, N. & SILVERMAN, R. (1948), *A statistical analysis of advertising expenditure and of the revenue of the press*. National Institute of Economic and Social Research: Occasional Papers, No. 8. Cambridge: University Press.
261. KALECKI, M. (1943), "The war-time trend of deposits", *Bull. Oxf. Inst. Statist.*, **5**, 63-6.
262. KALECKI, M. (1945), "On the Gibrat distribution", *Econometrica*, **13**, 161-70.
263. KATONA, G. (1949), "Analysis of dissaving", *Amer. Econ. Rev.*, **39**, 673-88.
264. KATONA, G. (1949), "Financial surveys among consumers", *Human Rel.*, **2**, 3-12.
265. KATONA, G. & RENSIS, L. (1946), "Relationship between consumer expenditures and savings: the contribution of survey research", *Rev. Econ. Statist.*, **28**, 197-9.
266. KEIRSTEAD, B. S. (1943), "Technical advance and economic equilibria", *Canad. J. Econ. Pol. Sci.*, **9**, 55-68.
267. KELLERER, H. (1949), "Neuere Stichprobenverfahren in der amtlichen Statistik unter besonderer Berücksichtigung amerikanischer Erfahrungen", *Allg. Statist. Arch.*, **33**, 83-112.
268. KENDALL, M. G. (1943), "Oscillatory movements in English agriculture", *J.R. Statist. Soc.*, **106**, 104-24.
269. KENDALL, M. G. (1945), "On the analysis of oscillatory time-series", *J.R. Statist. Soc.*, **108**, 91-141.
270. KENDALL, M. G. (1945), "Note on Mr. Yule's paper", *J.R. Statist. Soc.*, **108**, 226-30.
271. KENDALL, M. G. (1946), *Contributions to the Study of Oscillatory Time-series*. National Institute of Economic and Social Research: Occasional Papers, No. 9. Cambridge: University Press.
272. KEYFITZ, N. (1945), "The sampling approach to economic data", *Canad. J. Econ. Pol. Sci.*, **11**, 467-77.
273. KINGSTON, J., *A Desigualdade na distribuição das Rendas*. Rio de Janeiro: (mimeo.).
274. KINGSTON, J. (1947), "Factôres determinantes do preço do café", *Rev. Brasileira Estatist.*, **8**, 353-62.
275. KISSELGOFF, A. (1945), "Likelihood preference of large manufacturing corporations", *Econometrica*, **13**, 334-44.
276. KISSELGOFF, A. (1946), "'Free money' of large manufacturing corporations and the rate of interest: a reply", *Econometrica*, **14**, 254.
277. KLARMAN, H. E. (1943), "A statistical study of income differences among communities", *Studies in Income and Wealth*, **6**. New York: National Bureau of Economic Research, 206-35.
278. KLEIN, L. R. (1943), "Pitfalls in the statistical determination of the investment schedule", *Econometrica*, **11**, 246-58.
279. KLEIN, L. R. (1944), "The statistical determination of the investment schedule: a reply", *Econometrica*, **12**, 91-2.
280. KLEIN, L. R. (1946), "A post-mortem on transition predictions of national product", *J. Pol. Econ.*, **54**, 289-308.
281. KLEIN, L. R. (1947), "The use of econometric models as a guide to economic policy", *Econometrica*, **15**, 111-51.
282. KNAF, H. G. (1946), "Interstate differences in the saturation of wired homes, mechanical refrigerators and electric ranges and their causes", *J. Land Pub. Util. Econ.*, **22**, 386-92.
283. KOFFSKY, N. (1948), "An additional view on the consumption function", *Rev. Econ. Statist.*, **30**, 55-6.
284. KOOPMANS, T. C. (1945), "Statistical estimation of simultaneous economic relations", *J. Amer. Statist. Ass.*, **40**, 448-66.
285. KOOPMANS, T. C. (1947), "Statistical methods of measuring economic relationships". Chicago: Cowles Commission Discussion Paper, No. 310, 126 (mimeo.).
286. KOOPMANS, T. C. (1949), "Identification problems in economic model construction", *Econometrica*, **17**, 125-43.
287. KULL, W. (1945), "Erhebungen über Haushaltsrechnungen in den Vereinigten Staaten und der Schweiz", *Schweiz. Z. Volksw. Statist.*, **81**, 55-78.
288. KULL, W. (1949), "Zur Frage des regionalen Vergleichs der Konzentration der Einkommen natürlicher Personen", *Schweiz. Z. Volksw. Statist.*, **85**, 398-405.
289. KUZNETS, G. M. (1948), "The use of econometric models in agricultural micro-economic studies", *J. Farm Econ.*, **30**, 131-41.
290. KUZNETS, G. M. & KLEIN, L. R. (1943), "A statistical analysis of the domestic demand for lemons, 1921-1941", *California Sta. mimeog. rpt. No. 84*, 112.
291. LARSEN, H. S. (1949), "Om rentedannelsen for kreditfonensobligationer", *Nat. Økon. Tidsskr.*, **87**, 336-45.

292. LAURILA, E. H. (1949), "Suomen teollisuustuotannon volyymi vuosina 1938-1947" (The volume of the Industrial Production in Finland, 1938-1947), *Tilastokatsauksia (Recueil de Statistique)*, 24, 32-53.
293. LEBERGOTT, S. (1945), "Forecasting the national product", *Amer. Econ. Rev.*, 35, 59-80.
294. LEBERGOTT, S. (1947), "Wage structures", *Rev. Econ. Statist.*, 29, 274-85.
295. LENTI, L. (1942-43), "Vom Überleben der italienischen Aktiengesellschaften und ihres Kapitals (1933-1939)", *Allg. Statist. Arch.*, 31, 139-55.
296. LEONTIEF, W. W. (1944), "Output, employment, consumption and investment", *Q. J. Econ.*, 58, 290-314.
297. LEONTIEF, W. W. (1946), "Exports, imports, domestic output and employment", *Q. J. Econ.*, 60, 171-91, and errata 469.
298. LEONTIEF, W. W. (1946), "Wages, profit and prices", *Q. J. Econ.*, 61, 26-39.
299. LEWIS, W. A. (1949), *Overhead Costs*. London: Allen & Unwin, Ltd.
300. LISMAN, J. H. C. (1946/47), "Verklaring van het verloop van één verschijnsel uit den toestand op een oogenblik, toegepast op het giroverkeer", *Statistica (The Hague)*, 1, 63.
301. LISMAN, J. H. C. (1948), "Enige frequentieverschijnselen in het gelverkeer", *De Economist*, 96, 293-7.
302. LIVINGSTON, S. M. (1945), "The postwar price structure", *Surv. Curr. Bus.*, 25, No. 11, 12.
303. LIVINGSTON, S. M. (1945), "Forecasting postwar demand: II", *Econometrica*, 13, 15-24.
304. LOMAX, K. S. (1948), "Analysis of demand and supply in textiles", *Manch. Sch. Econ. Social Stud.*, 16, 46-65.
305. LOMAX, K. S. (1949), "An agricultural production function for the United Kingdom, 1924 to 1947", *Manch. Sch. Econ. Social Stud.*, 17.
306. LUBELL, H. (1947), "Effects of redistribution of income on consumers' expenditures", *Amer. Econ. Rev.*, 37, 157-70, and comments by LUBELL, H., et al., 930-3.
307. LYLE, P. (1946), *Regression Analysis of Production Costs and Factory Operations*, 2nd ed., revised. Edinburgh and London: Oliver & Boyd, Ltd.
308. MACK, R. P. (1948), "Change in income and the consumption function", *Rev. Econ. Statist.*, 30, 239-58.
309. MADGE, C. et al. (1943), "War-time pattern of saving and spending", *National Institute of Economic and Social Research: Occasional Papers No. 4*. Cambridge: University Press.
310. MAFFRY, A. (1944), "Foreign trade in the postwar economy", *Surv. Curr. Bus.*, 24, No. 11, 5-14.
311. MAHALANOBIS, P. C. (1943), "Enquiry into the prevalence of drinking tea among middle-class Indian families in Calcutta: 1939", *Sankhyā*, 6, 283-312.
312. MAHALANOBIS, P. C. (1945), "Report on the Bihar crop survey: Rabi season 1943-44", *Sankhyā*, 7, 29-106.
313. MAHALANOBIS, P. C. (1946), "Sample surveys of crop yields in India", *Sankhyā*, 7, 269-80.
314. MAHALANOBIS, P. C., et al. (1946), "A sample survey of after-effects of the Bengal famine of 1943", *Sankhyā*, 7, 337-400.
315. MAINGUY, Y. (1946), "Salaire et consommation", *Inst. Sci. Econ. Appl. Cahiers, (B)*, No. 3.
316. MAINGUY, Y. (1948), "La consommation incompressible", *Econ. Appl.*, 1, 68-110.
317. MAINGUY, Y. & GUILBAUD, G.-Th. (1947), "Les différents comportements du consommateur et leur détermination statistique", *Inst. Sci. Econ. Appl. Cahiers, (B)*, annexes No. 4, 1-63.
318. MALMQUIST, S. (1948), *A Statistical Analysis of the Demand for Liquor in Sweden*. Uppsala: Appelbergs Boktryckerieaktiebolag.
319. MANDEL, B. (1949), "Measuring intercity differences in living costs", *Mon. Lab. Rev.*, 68, 315-21.
320. MANNE, A. S. (1945), "Some notes on the acceleration principle", *Rev. Econ. Statist.*, 27, 93-99.
321. MARCHAL, A. (1948), "De la théorie à la prévision par la méthode des modèles", *Rev. Econ. Pol.*, 58, 481-512.
322. MARRAMA, V. (1949), "La teoria della crisi alla luce dei recenti documenti", *G. Econ. Ann. Econ. Milan*, 8, n.s., 502-20.
323. MARSCHAK, J. (1943), "Income inequality and demand studies: a note", *Econometrica*, 11, 163-6.
324. MARSCHAK, J. (1943), "Money illusion and demand analysis", *Rev. Econ. Statist.*, 25, 40-8.
325. MARSCHAK, J. & ANDREWS, W. H., Jr. (1944), "Random simultaneous equations and the theory of production", *Econometrica*, 12, 143-205.
326. MAVERICK, L. A. (1945), *Time Series Analysis: Smoothing by Stages*. San Antonio, Texas: Paul Anderson.
327. MCCORMICK, T. C. (1943), "An approach to the measurement of farm population pressure in Wisconsin", *J. Amer. Statist. Ass.*, 38, 165-77.
328. McDUGALL, J. L. (1947), "The distribution of income among wage workers in railway employment, 1939-47", *Canad. J. Econ. Pol. Sci.*, 13, 248-55.
329. MCHUGH, L. F. (1947), "Consumer credit in the postwar period", *Surv. Curr. Bus.*, 27, No. 11, 11-5 and 24.
330. McMILLAN, R. T. (1946), "Are tenure differences due to tenure?", *J. Farm Econ.*, 28, 1029-36.
331. MEHREN, G. L. & ERDMAN, H. E. (1946), "An approach to the determination of intraseasonal shifting of demand", *J. Farm Econ.*, 28, 587-96.
332. MEHRING, A. L. & SHAW, B. T. (1944), "Relationships between farm income and farmers' expenditures for fertilizer and a forecast of the commercial demand for fertilizer in 1944 and 1945 by states", *The Amer. Fertilizer*, 8.
333. MENDERSHAUSEN, H. (1946), "Changes in income distribution during the great depression", *Studies in Income and Wealth*, 7. New York: National Bureau of Economic Research, 1-171.

1951]

334. MILHAU, J. (1948), "Le prix du vin et les revenus viticoles", *Étud. Conj., Union Franç.*, 3, 65-74, and (1949), 4, 57-62.
335. MILLER, L. F. & PRESTON, H. J. (1948), "Relation of feed, labor, and other costs to butterfat test", *J. Farm Econ.*, 30, 566-73.
336. MODIGLIANI, F. (1947), "Fluctuations in the savings ratio", *Social Res.*, 14, 413-20.
337. MODIGLIANI, F. (1949), "Fluctuations in the saving-income ratio: a problem in economic forecasting", *Studies in Income and Wealth*, 11. New York: National Bureau of Economic Research, 369-443.
338. MONAVON, — (1947), *L'analyse de la confluence par la méthode de R. Frisch*, Thèse Inst. de Stat. de Paris.
339. MOORE, G. H. & WALLIS, W. A. (1943), "Time series significance tests based on signs of differences", *J. Amer. Statist. Ass.*, 38, 153-64.
340. MORAES, O. A. (1943), "Números índices" suas aplicações na Estatística Brasileira", *Rev. Brasileira Estatist.*, 4, 641-52.
341. MORTARA, G. (1949), "Dados e observações a distribuição das rendas de pessoas físicas contribuintes de imposto de renda no Brasil", *Rev. Brasileira Estatist.*, 10, 197-222.
342. MORTARA, G. (1946), "Pesquisas demo-econometricas". Rio de Janeiro: *Estudos Brasileiros de Demografia*, Monograph No. 2.
343. MOSAK, J. L. (1945), "Forecasting postwar demand: III", *Econometrica*, 13, 25-37.
344. MOURRE, L. B. (1943), "Definitions de l'inégalité des revenus et utilisation de la formule de Pareto", *J. Soc. Statist. Paris*, 84, 228-40.
345. MUKHERJEA, R. & MUKHERJEE, M. M. (1946), "A note on concentration of income in Bengal villages", *Sankhyā*, 7, 327-8.
346. MUNZER, E. (1945), "Exports and national income in Canada", *Canad. J. Econ. Pol. Sci.*, 11, 35-47.
347. MUSGRAVE, R. A. & MILLER, M. H. (1948), "Built-in flexibility", *Amer. Econ. Rev.*, 38, 122-8.
348. MUSGRAVE, R. A. & PAINTER, M. S. (1948), "The impact of alternative tax structures on personal consumption and saving", *Q. J. Econ.*, 62, 475-99.
349. MUSGRAVE, R. A. & THIN, T. (1948), "Income tax progression, 1929-1948", *J. Pol. Econ.*, 56, 498-514.
350. National Planning Association (1945), "Fertilizers in the postwar national economy", *Planning pamphlets*, 42, 21-6.
351. NELSON, A. G. (1946), "Input-output relationships in fattening cattle", *J. Farm Econ.*, 28, 495-514.
352. NEWMAN, D. K. (1949), "Estimating national housing volume", *Mon. Lab. Rev.*, 69, 410-6.
353. NICHOLLS, W. H. (1948), *Labor Productivity Functions in Meat Packing*. Chicago: University of Chicago Press.
354. NICHOLSON, J. L. (1944), "The distribution of incomes", *Bull. Oxf. Inst. Statist.*, 6, 23-9.
355. NICHOLSON, J. L. (1946), "Earnings, hours, and mobility of labour", *Bull. Oxf. Inst. Statist.*, 8, 146-63.
356. NICHOLSON, J. L. (1949), "Variations in working class expenditure", *J.R. Statist. Soc.*, 112, 359-418.
357. NORDIN, J. A. (1947), "Note on a light plant's cost curves", *Econometrica*, 15, 231-5.
358. NOYES, C. E. & HILGARD, E. R. (1946), "Estimated income distribution in three surveys of consumer requirements", *Studies in Income and Wealth*, 8. New York: National Bureau of Economic Research, 263-77.
359. OLSON, E. C. (1948), "Factors affecting international differences in production", *Amer. Econ. Rev.*, 38, 502-22 (proceedings, Dec., 1947).
360. ORCUTT, G. H. (1948), "A study of the autoregressive nature of the time series used for Tinbergen's model of the economic system of the United States, 1919-1932", *J.R. Statist. Soc.*, (B), 10, 1-53.
361. ORCUTT, G. H. & COCHRANE, D. (1949), "A sampling study of the merits of autoregressive and reduced form transformations in regression analysis", *J. Amer. Statist. Ass.*, 44, 356-72.
362. ORCUTT, G. H. & JAMES, S. F. (1948), "Testing the significance of correlation between time series", *Biometrika*, 35, 397-413.
363. OSGOOD, O. T. (1949), "Results of two sampling methods used in farm management research", *J. Farm Econ.*, 21, 157-68.
364. OU, P-S. (1946), "A new estimate of China's national income", *J. Pol. Econ.*, 54, 547-54.
365. OVERTON, R. S. (1949), "Use of semi-controlled mail surveys for initiating new statistical series", *Agric. Econ. Res.*, 1, 87-92.
366. PARADISO, L. J. (1944), "Retail sales and consumer incomes", *Surv. Curr. Bus.*, 24, No. 10, 5, and 26, No. 10, 10-17.
367. PARADISO, L. J. (1945), "Classification of consumer expenditures by income-elasticity", *Surv. Curr. Bus.*, 25, No. 1, 7-10.
368. PARADISO, L. J. (1945), "How can business analyse its markets?", *Surv. Curr. Bus.*, 25, No. 3, 6-13.
369. PARADISO, L. J. (1948), "Significance of inventories in the current economic situation", *J. Amer. Statist. Ass.*, 43, 361-76.
370. PATZIG, R. E. & HADARY, G. (1945), "Relationship of income to milk consumption", *J. Farm Econ.*, 27, 204-10.
371. PECHMAN, J. A. (1948), "Patterns of income", *Research in Income and Wealth*, 9. New York: National Bureau of Economic Research, 59-151.
372. PENDHARKAR, V. G. & MATHUR, G. D. (1943), "Monthly fluctuations in raw jute prices", *Sankhyā*, 6, 265-70.
373. PERLMAN, J. & MANDEL, B. (1944), "The continuous work history sample under old-age and survivors insurance", *Social Sec. Bull.*, 7, 12-22.

VOL. CXIV. PART III.

25

374. PHILIP, K. (1948), "Forsøg på en statistik måling af bankernes likviditetes præference", *Ekon. Tidskr.*, 50, 131-42.
375. PIZZETTI, E. (1948), "Sensibilità degli indici di concentrazione", *G. Econ. Ann. Econ. Milan*, 7, N.S., 101-6.
376. PLESSING, H. C. (1948), "Problems of telephone economy as seen from a statistical point of view", *Nord. Tidskr. Tek. Økon.*, 12, 201-13.
377. PREINREICH, G. A. D. (1948), "Progressive taxation and proportionate sacrifice", *Amer. Econ. Rev.*, 38, 103-17.
378. PREST, A. R. (1948), "Notes on the history of the Giffen paradox: comment", *J. Pol. Econ.*, 56, 58-60.
379. PREST, A. R. (1949), "Some experiments in demand analysis", *Rev. Econ. Statist.*, 31, 33-49.
380. PREST, W. (1945), "Rents in Melbourne", *Econ. Rec.*, 21, 37-54.
381. PUBOLS, B. H. & KLAMAN, S. B. (1945), *Farmers' Response to Price in the Production of Potatoes, 1922-1941*. U.S. Dept. Agric., Bur. Agric. Econ.
382. QUENOUILLE, M. H. (1947), "A large sample test for the goodness of fit of autoregressive schemes", *J.R. Statist. Soc.*, 110, 123-9.
383. QUENOUILLE, M. H. (1949), "Approximate tests of correlation in time series", *J.R. Statist. Soc.*, (B), 11, 68-84.
384. QUENSEL, C-E. (1945), "Den nya inkomstatistiken", *Ekon. Tidskr.*, 47, 346-52.
385. QUENSEL, C-E. (1948), "En utvidgad inkomstatistik", *Ekon. Tidskr.*, 50, 1-9.
386. RASMUSSEN, P. N. (1948), "Some remarks on the joint effects of simultaneous relations between economic variables", *Nord. Tidskr. Tek. Økon.*, 12, 215-22.
387. RASMUSSEN, P. N. (1949), "Om estimerings problemer for makromodeller", *Nat. Økon. Tidsskr.*, 87, 59-69.
388. REDER, M. W. (1943), "An alternative interpretation of the Cobb-Douglas function", *Econometrica*, 11, 259-64.
389. REEVE, E. G. (1946), *Carpets*, The Social Survey, N.S., No. 82. London: Central Office of Information.
390. REIERSÖL, O. (1945), "Confluence analysis by means of instrumental sets of variables", *Arkiv för Matematik, Astronomi, och Fysik*, 32A, 1-119.
391. REITZ, J. W. (1945), "War-time control of fresh citrus fruits", *J. Farm Econ.*, 27, 553-70.
392. REMERY, — (1946), *Distribution et dispersion des prix français depuis 1929*, Thèse Inst. de Stat. de Paris and *Bulletin mensuel*, I.N.S.E.E., 242-57.
393. RHODES, E. C. (1943), "The distribution of incomes in the United States", *Economica*, 10, 223-32.
394. RHODES, E. C. (1944), "The Pareto distribution of incomes", *Economica*, 11, 1-11.
395. RHODES, E. C. (1944), "Comments on Dr. Garvy's note", *Economica*, 11, 106.
396. RHODES, E. C. (1945), "The distribution of family incomes", *Economica*, 12, 31-5.
397. RHODES, E. C. (1945), "Output, labour and machines in the coal mining industry in Great Britain", *Economica*, 12, 101-10.
398. RHODES, E. C. (1949), "The distribution of earned and investment incomes in the United Kingdom", *Economica*, 16, 53-65.
399. RIEBESELL, P. (1949), "Ein einfaches Stabilitätsmass und seine Anwendung in der Versicherung", *Mitteil. Math. Arch.*, 1, 181-4.
400. ROBERTS, D. R. (1944), "The distribution of private, non-agricultural employees in the United States by straight-time hourly wage rates", *J. Amer. Statist. Ass.*, 39, 469-78.
401. ROOS, C. F. (1948), "The demand for investment goods", *Amer. Econ. Rev.*, 38, 311-20.
402. ROOS, C. F. & VON SZELISKI, V. S. (1943), "The demand for durable goods", *Econometrica*, 11, 97-122.
403. ROSA, R. V. (1948), "Use of the consumption function in short run forecasting", *Rev. Econ. Statist.*, 30, 91-105.
404. ROSTAS, L. (1948), "Productivity, prices and distribution in selected British industries", *National Institute of Economic and Social Research: Occasional Papers* No. 11. Cambridge: University Press.
405. ROTHSCHILD, K. (1945), "Wages and risk-bearing", *Bull. Oxf. Inst. Statist.*, 7, 193-8.
406. ROUQUET LA GARRIQUE, V. (1947), "Conclusions et détections économétriques", *J. Soc. Statist. Paris*, 88, 110-34.
407. ROUQUET LA GARRIQUE, V. (1948), "Innovations et suggestions économétriques", *J. Soc. Statist. Paris*, 89, 42-63.
408. ROUQUET LA GARRIQUE, V. (1948), *Les problèmes de la corrélation et de l'élasticité*. Paris: Vols. 1 and 2, Hermann et Cie. Bordeaux: Vols. 3 and 4, the author, Faculté de Droit de l'Université de Bordeaux (Roneotype).
409. ROUQUET LA GARRIQUE, V. (1949), "Fluctuations longues et oscillations cycliques", *J. Soc. Statist. Paris*, 90, 298-313.
410. ROY, G. C. (1944), "On the application of time series to the data relating to the Indian posts and telegraphs department", *Sankhyā*, 6, 391-8.
411. ROY, R. (1949), "Les nombres indices", *J. Soc. Statist. Paris*, 90, 15-34.
412. ROY, R. (1949), "Pareto statisticien: la distribution des revenus", *Rev. Econ. Pol.*, 59, 554-77.
413. RUGGLES, R. & BRODIE, H. (1947), "An empirical approach to economic intelligence in World War II", *J. Amer. Statist. Ass.*, 42, 72-91.
414. RUIST, E. (1945), "Standard errors of the tilting coefficients used in confluence analysis", *Econometrica*, 15, 235-41.

1951]

415. RUIST, E. & SVENNILSON, J. (1948), *Den norrländska skogsnäringens konjunkturänslighet under mellankrigsperioden*. Stockholm: Industriens utredningsinstitut, 198.
416. RUTHERFORD, R. S. G. (1948), "Fluctuations in the sheep population of New South Wales, 1860-1940", *Econ. Rec.*, 24, 56-71.
417. SADIE, J. L. (1948), "European population movements in South Africa during world war II", *S. Afr. J. Econ.*, 16, 51-79.
418. SAGOROFF, S. (1949), "Die Berechnung des Volkseinkommens als statistisches Problem", *Allg. Statist. Arch.*, 33, 171-90.
419. SANDERSON, F. H. (1943), "A specific scheme for wheat crop insurance", *J. Farm Econ.*, 25, 759-76.
420. SAPIR, M. (1949), "Review of economic forecasts for the transition period", *Studies in Income and Wealth*, 11. New York: National Bureau of Economic Research, 273-367.
421. SARLE, C. F. (1949), "Need for special-purpose sampling in estimating agricultural production", *Agric. Econ. Res.*, 1, 134-8.
422. SARLE, C. F. & ROBINSON, T. C. M. (1949), "Measurement of agricultural production", *J. Farm Econ.*, 31, 213-31.
423. SCHNEIDER, E. (1947), (1949), *Einführung in die Wirtschaftstheorie*. Vol. 1: *Theorie des Wirtschaftskreislaufs*. Vol. 2: *Wirtschaftspläne und wirtschaftl. Gleichgewicht in der Verkehrswirtschaft*. Tübingen: Verlag Mohr.
424. SCHOLL, J. C. & BURKHEAD, C. E. (1949), "Interviewing non-respondents to a mail survey: an experiment in connection with April 1948 farm stocks report", *Agric. Econ. Res.*, 1, 16-23.
425. SCHULTZ, T. W. (1945), *Agriculture in an Unstable Economy* (Committee for Economic Development Research Study). New York: McGraw-Hill.
426. SCHULZ, T. (1943-49), "Working class budgets in war-time: family income and expenditure", *Bull. Oxf. Inst. Statist.*, 5, 41-9, 6, 3-27, 7, 17-30, 8, 29-43, 9, 133-69, 10, 353-72, 401-19.
427. SEERS, D. (1947), "The coal shortage: future prospects", *Bull. Oxf. Inst. Statist.*, 9, 170-6.
428. SEERS, D. (1949), *Changes in the cost of living and the distribution of income since 1938*, Oxf. Univ. Inst. Statist. Oxford: Blackwell, and *Bull. Oxf. Inst. Statist.*, 1948.
429. SELBY, H. E. (1945), "Factors affecting value of land and water in irrigated land", *J. Land Pub. Util. Econ.*, 21, 250-8.
430. SIELAFF, T. J. (1945), "Postwar wholesale dry goods sales and stores", *J. Marketing*, 10, 60-2.
431. SILBERLING, N. J. (1943), *The Dynamics of Business*. New York: McGraw-Hill.
432. SINGER, H. W. & LESER, C. E. V. (1948), "Industrial productivity in England and Scotland", *J.R. Statist. Soc.*, 111, 309-30.
433. SINGH, J. (1945), "Incidence of ticketless travelling on the Lucknow-Cawnpore section of the East Indian Railway", *Sankhyā*, 7, 211-2.
434. SITTING, J. (1949), "Het probleem der waarnemingsfouten bij een massaal onderzoek", *Statistica* (The Hague), 3, 49-68.
435. SLATER, P. (1947), *Final Report on the Demand for Holidays in 1946 and 1947*, The Social Survey, N.S. London: Central Office of Information.
436. SLATER, P. (1948), *Report on the Demand for Holidays in 1947 and 1948*, The Social Survey, N.S. London: Central Office of Information.
437. SLITOR, R. E. (1948), "The measurement of progressivity and built-in flexibility", *Q. J. Econ.*, 62, 309-13.
438. SMELKER, M. W. (1948), "Shifts in the concentration of income", *Rev. Econ. Statist.*, 30, 215-22.
439. SMITH, G. C., Jr. (1947), "Lorenz curve analysis of industrial decentralization", *J. Amer. Statist. Ass.*, 42, 591-6.
440. SMITH, J. H. (1946), "Constant-amplitude scales for plotting stock prices", *Econometrica*, 14, 316-9.
441. SMITH, M. A. (1945), "Probable postwar sales in Michigan", *Surv. Curr. Bus.*, 25, No. 5, 16-8.
442. SMITH, T. et al. (1947), "Commercial bank loans to farmers", *Fed. Reserve Bull.*, 33, 1216-27, 1469-92.
443. SMITH, V. E. (1945), "Nonlinearity in the relation between input and output. The Canadian automobile industry, 1919-1930", *Econometrica*, 13, 260-72.
444. SMITH, V. E. (1945), "The statistical production function", *Q. J. Econ.*, 59, 543-62.
445. SMITHIES, A. (1945), "Forecasting post-war demand: I", *Econometrica*, 13, 1-14.
446. SNYDER, E. M. & LANALIAN, T. J., Jr. (1949), "Family income and expenditures: Los Alamos, 1948", *Mon. Lab. Rev.*, 69, 247-51.
447. SOMERMEIJER, W. H. (1949), "Een poging tot kwantitatieve verklaving van interprovinciale huursverschillen in Nederland", *Statist. Econ. OndZoeck.*, 4, 43-59.
448. SPENGLER, J. J. (1947 & 1948), "Aspects of the economics of population growth", *Sth. Econ. J.*, 14, 123-47 and 233-65.
449. STAEHLE, H. (1943), "Ability, wages and income", *Rev. Econ. Statist.*, 25, 77-87.
450. STAEHLE, H. (1945), "Relative prices and postwar markets for animal food products", *Q. J. Econ.*, 59, 237-79.
451. STEINDL, J. (1944 & 1945), "Post-war employment in the United States", *Bull. Oxf. Inst. Statist.*, 6, 193-202, and 7, 213-7.
452. STEINDL, J. (1945), "Long-run changes in the propensity to save—a reply (to Colin Clark)", *Bull. Oxf. Inst. Statist.*, 7, 103-13.
453. STEPHAN, F. F. (1948), "History of the uses of modern sampling procedures", *J. Amer. Statist. Ass.*, 43, 12-39.
454. STERN, E. H. (1945), "Capital requirements in progressive economies", *Economica*, 12, 163-71.

455. STIGLER, G. J. (1946), "Labor productivity and size of farm: a statistical pitfall", *J. Farm Econ.*, 28, 821-5.
456. STIGLER, G. J. (1947), "The kinky oligopoly demand curve and rigid prices", *J. Pol. Econ.*, 55, 434-49.
457. STIGLER, G. J. (1947), "Notes on the history of the Giffen paradox", *J. Pol. Econ.*, 55, 152-6.
458. STIGLER, G. J. (1948), "A reply (to A. R. Prest)", *J. Pol. Econ.*, 56, 61-2.
459. STONE, J. R. N. (1942-43), "National income in the United Kingdom and the United States of America", *Rev. Econ. Stud.*, 10, 1-27, and *Manch. Statist. Soc. Trans.*, October, 1942.
460. STONE, J. R. N. (1943), "Two studies on income and expenditure in the United States", *Econ. J.*, 53, 60-75.
461. STONE, J. R. N. (1944), "Employment in U.S. manufacturing", *Econ. J.*, 54, 246-52.
462. STONE, J. R. N. (1945), "The analysis of market demand", *J.R. Statist. Soc.*, 108, 286-391.
463. STONE, J. R. N. (1947), "On the interdependence of blocks of transactions", *J.R. Statist. Soc. Suppl.*, 9, 1-45.
464. STONE, J. R. N. (1947), "Prediction from autoregressive schemes and linear stochastic difference systems", *Proc. Int. Statist. Inst.*, Washington, and (1948) abstracted in *Econometrica*, 16, 38-40.
465. STONE, J. R. N. (1948), "The analysis of market demand—an outline of methods and results", *Rev. Int. Statist. Inst.*, 16, 23-35.
466. STONE, J. R. N. & JACKSON, E. F. (1946), "Economic models, with special reference to Mr. Kaldor's system", *Econ. J.*, 56, 554-67.
467. STRAND, N. V. & JESSEN, R. J. (1943), "Some investigations on the suitability of the township as a unit for sampling Iowa agriculture", *Iowa Sta. Res. Bull.*, 613-50.
468. STRECKER, H. (1949), "Die Quotientenmethode, ein Variante der 'Variate Difference' Methode", *Mitteil. Math. Statist.*, 1, 115-30.
469. SVENDSEN, A. S. (1948), "Ökonometriske metoder", *Econ. Tidskr.*, 50, 219-32.
470. SZATROWSKI, Z. (1945), "The consistency of U.S.D.A. estimates of possible consumption and prices of beef and pork in 1950", *J. Farm Econ.*, 27, 984-9.
471. SZATROWSKI, Z. (1945), "The relationship between price changes and price level for common stocks", *J. Amer. Statist. Ass.*, 40, 467-83.
472. SZATROWSKI, Z. (1945), "Time series correlated with the beef-pork consumption ratio", *Econometrica*, 13, 60-78.
473. TAMMINEN, M. (1945), *Suomen kaupunkien asuntotuotannon vaihtelut ja niiden syyt itsenäisyyden aikana* (The fluctuations in residential building and their causes in the towns of Finland during the time of independence). Helsinki.
474. TAYLOR, C. T. (1944), "Voluntary saving and consumer behaviour", *Sth. Econ. J.*, 10, 239-45.
475. THIONET, P. (1945), "Essai de détermination du stock optimum", *J. Soc. Statist. Paris*, 86, 99-122.
476. THIONET, P. (1945 & 1946), "L'école moderne de statisticiens italiens", *J. Soc. Statist. Paris*, 86, 245-55, and 87, 16-34.
477. THOMAS, G. (1947), *The Employment of Older Persons*, The Social Survey, n.s. 60/2. London: Central Office of Information.
478. THOMPSON, S. H. et al. (1945), *National Budgets for Full Employment*. New York: National Planning Ass. pamphlet.
479. THOMSEN, F. L. & BOLLINGER, P. H. (1943), "Forecasting national income and related measures", *Studies in Income and Wealth*, 6. New York: National Bureau of Economic Research, 170-204.
480. TINBERGEN, J. (1944), "Ligevaegstyper og konjunkturbevaegelse", *Nord. Tidskr. Tek. Økon.*
481. TINBERGEN, J. (1946), "Some measurements of elasticities of substitution", *Rev. Econ. Statist.*, 18, 109-16.
482. TINBERGEN, J. (1946), *Welke mogelijkheden en middelen bestaan er tot het in evenwicht brengen van de betalingsbalans van Nederland na afloop Van de Marshall—hulp onder gelyktijdig streven naar een overwegend vryer internationaal handels—en betalingsverkeer*, Overdrukken 6. Hague: Central planbureau.
483. TINBERGEN, J. (1947), "The use of correlation analysis in economic research", *Ekon. Tidskr.*, 49, 173-92.
484. TINBERGEN, J. (1947), "Some problems in the explanation of interest rates", *Q. J. Econ.*, 61, 397-438.
485. TINBERGEN, J. (1947), "Quelques estimations de l'influence des contingentements 1933-1938 sur l'emploi aux Pay-Bas", *Rev. Inst. Int. Statist.*, 15, 8-23.
486. TINBERGEN, J. (1948), "De schommelingen van de invoer 1923-1938", *Statist. Econ. Ondzoek.*, 3, 52-60.
487. TINBERGEN, J. (1948), "Le problème de la rareté du dollar", *Rev. Econ. Pol.*, 58, 36-56.
488. TINBERGEN, J. (1949), "Long-term foreign trade elasticities", *Metroeconomica*, 1, 174-85.
489. TINTNER, G. (1944), "The 'simple' theory of business fluctuations: a tentative verification", *Rev. Econ. Statist.*, 26, 148-57.
490. TINTNER, G. (1944), "A note on the derivation of production functions from farm records", *Econometrica*, 12, 26-34.
491. TINTNER, G. (1944), "An application of the variate difference method to multiple regression", *Econometrica*, 12, 97-113.
492. TINTNER, G. (1946), "Some applications of multivariate analysis to economic data", *J. Amer. Statist. Ass.*, 41, 472-500.
493. TINTNER, G. (1946), "Multiple regression for systems of equations", *Econometrica*, 14, 5-36.
494. TINTNER, G. (1947), "Une théorie 'simple' des fluctuations économiques", *Rev. Econ. Pol.*, 57, 209-15.

1951]

495. TINTNER, G. (1949), "La position de l'économétrie dans la hierarchie des sciences sociales", *Rev. Econ. Pol.*, 59, 634-41.
496. TINTNER, G. (1949), "Scope and method of econometrics", *J. Statist. Social Inquiry Soc. Ireland*, 21, 1-15.
497. TINTNER, G. (1949), "Static macro-economic models and their econometric verifications", *Metroeconomica*, 1, 48-52.
498. TINTNER, G. & BROWNLEE, O. H. (1944), "Production functions derived from farm records" *J. Farm Econ.*, 26, 566-71.
499. TOLONEN, U. (1948), "Kausivaihtelun muutoksista ja eräistä laskumenetelmistä niiden tutkimiseksi" (About the seasonal changes and some methods of measuring them), *Kansantaloudellinen aikakauskirja*, 44, 133-56.
500. TÖRNQVIST, L. (1945), "Prisbildningsproblemet betraktat ur sannolikheteoretisk dynamisk synvinkel", *Ekonomiska Samfundets Tidskrift*, 65, 47-65.
501. TORTIL, M. (1948), "Revenu et production des nations", *J. Soc. Statist. Paris*, 89, 306-21.
502. TSIANG, S.-C. (1947), *The Variations of Real Wages and Profit Margins in Relation to the Trade Cycle*. London: Pitman.
503. ULMER, M. J. & NIELSON, A. (1947 & 1948), "The business population", Pts. I-VI, *Surv. Curr. Bus.*, 27 and 28.
504. UNITED NATIONS (1948 & 1949), "Analyses of field enquiries into the living conditions of selected social groups", Miscellanies 1, 2, 3. Lake Success.
505. UNITED NATIONS DEPT. OF ECONOMIC AFFAIRS, ECONOMIC COMMISSION FOR EUROPE, STEEL DIVISION (1949), "European steel trends in the setting of the world market", Geneva, 148.
506. UNITED NATIONS STATISTICAL COMMISSION, SUB-COMMISSION ON STATISTICAL SAMPLING (1949), "Report . . . on the third session . . . on statistical sampling . . . Sept., 1949", Geneva, E/CN.3/83, E/CN.3/Sub.1/20.
507. UTTING, J. E. G. (1949), "Social accounting—some first results of the enquiry", *Local Govt. Finance*, 53, 9-13.
508. UTTING, J. E. G. (1949), "The social accounting inquiry for 1947-48", *Local Govt. Finance*, 53, 289-90.
509. VAN ETTINGER, J. (1949), "Statistische ervaringen in 1948", *Statistica (The Hague)*, 3, 3-7.
510. VAN HOUTTE, F.-X. (1949), *L'évolution de l'industrie textile en Belgique et dans le monde de 1800 à 1939*. Louvain: Institut de recherches économiques et sociales.
511. VAN OLST, H. R. (1948), "Differentievergelijkingen als uitdrukkinsswijze voor de stabiliteit van het economische leven", *Statist. Econ. Ondzoek.*, 3, 12-25.
512. VAN OLST, H. R. & IGNATIUS, J. G. W. (1948), "De prijsvorming van aadbeien", *Statist. Econ. Ondzoek.*, 3, 84-91.
513. VERDOORN, P. J. (1943), *Der Verstarrung der Productiekosten*. Haarlem.
514. VERDOORN, P. J. (1947), "Loonshoogte en werkgelegenheid", *De Economist*, 95, 513-39.
515. VERDOORN, P. J. (1949), "Fattori che regolano lo sviluppo della produttività del lavoro", *L'industria*, 45.
516. VERHULST, M. J. (1948), "The pure theory of production applied to the French gas industry", *Econometrica*, 16, 295-308.
517. VIANELLI, S. (1948), "Di alcune costanti caratteristiche nell'analisi delle serie storiche", *Ann. Fac. Econ. Comm. Palermo*, 2, 93-138.
518. VICKERY, C. W. (1944), "Cyclically invariant graduation", *Econometrica*, 12, 19-25.
519. VICKREY, W. (1947), "Resource distribution patterns and the classification of families", *Studies in Income and Wealth*, 10. New York: National Bureau of Economic Research, 266-329.
520. VILLIERS, — (1948), *Étude économétrique du prix du sucre en France depuis le début du XIXième siècle*. Bordeaux: Thèse Bordeaux (dactylographiée).
521. WALD, H. P. (1945), "War-strengthened railroads face new prospects", *Surv. Curr. Bus.*, 25, No. 12, 9-17.
522. WALD, H. P. (1946), "The expanded money supply and gross national product", *Surv. Curr. Bus.*, 26, No. 5, 8-15.
523. WALSH, R. M. (1943), "Export market and price of lard", *J. Farm Econ.*, 25, 487-94.
524. WALSH, R. M. (1944), "Response to price in production of cotton and cottonseed", *J. Farm Econ.*, 26, 359-72.
525. WARIS, K. (1945), *Kuluttajain tulot, kulutus ja säästämisen suhdannekehityksen valossa suomessa vuosina 1926-1938* (Consumers' incomes, consumption and saving as influenced by the cyclical fluctuations in Finland). Helsinki.
526. WARNER, L. (1947), "Estimating the character of unsampled segments of a universe", *J. Marketing*, 12, 186-92.
527. WEBER, A. & LINDER, A. (1949), "Emploi d'une méthode statistique pour étudier les dépenses d'une famille", *Schweiz. Z. Volksw. Statist.*, 85, 389-97.
528. WEIN, H. H. (1947), "Wages and prices—a case study", *Rev. Econ. Statist.*, 29, 108-23.
529. WILCOX, W. W. (1946), "Small farms in Wisconsin", *J. Farm Econ.*, 28, 458-75.
530. WILCOX, W. W. & RAUCHENSTEIN, E. (1948), "The effect of size of herd on milk production costs", *J. Farm Econ.*, 30, 713-23.
531. WILLIAMS, J. (1945), "Professor Douglas' production function", *Econ. Rec.*, 21, 55-64.
532. WILSON, D. S. (1946), "Postwar farm markets", *Surv. Curr. Bus.*, 26, No. 6, 14-20.
533. WILSON, D. S. (1946), "Postwar role of business inventories" *Surv. Curr. Bus.*, 26, No. 10, 25-31.

534. WILSON, E. B. & WORCESTER, J. (1945), "The normal logarithmic transform", *Rev. Econ. Statist.*, 27, 17-22.
535. WINKLER, W. (1948), "Ein Mass der Seelischen Komponente des Geburtenrückganges", *Statist. Vjschr.*, 1, 94-9.
536. WINKLER, W. (1949), "The corrected Pareto law and its economic meaning", Paper No. 6, 26th session, Int. Statist. Inst., Berne.
537. WINKLER, W. (1949), "Das erweiterte 'Paretosche Gesetz' und seine ökonomische bedeutung", *Statist. Vjschr.*, 2, 124-43.
538. WINKLER, W. (1949), "Statistik und Wirtschaftslehre", *Z. Nat. ökon.*, 12, 429-41.
539. WINSTON, C., and SMITH, M. A. (1946), "Sensitivity of state income payments to nation's total", *Surv. Curr. Bus.*, 26, No. 1, 6-9 and 19.
540. WINSTON, C. & SMITH, M.A. (1948), "Retail sales and consumer income", *Surv. Curr. Bus.*, 28, No. 10, 12-9 and 23.
541. WINSTON, C. L., et al. (1946 & 1947), "The pattern of chain store sales", *Surv. Curr. Bus.*, 26, No. 10, 18-24; 27, No. 6, 11-16, and No. 9, 18-23.
542. WITTEVEEN, H. J. (1947), *Loonshoogte en werkgelegenheid*, Haarlem.
543. WOODBURY, R. M. (1949), "The incidence of industrial disputes", *Int. Lab. Rev.*, 60, 451-66.
544. WORKING, H. (1949), "The investigation of economic expectations", *Amer. Econ. Rev.*, 39 (proceedings, 1948), 150-66.
545. WOYTINSKY, W. S. (1945 & 1946), "Postwar economic perspectives", *Social Sec. Bull.*, 8, 18-29 and 9, 8-16, 9-16, 11-25.
546. WOYTINSKY, W. S. (1946), "Relationship between consumers' expenditures, savings, and disposable income", *Rev. Econ. Statist.*, 28, 1-12.
547. WOYTINSKY, W. S. (1947), "What was wrong in forecasts of postwar depression?", *J. Pol. Econ.*, 55, 142-51.
548. WOYTINSKY, W. S. (1948), "Consumption-saving function: its algebra and philosophy", *Rev. Econ. Statist.*, 30, 45-55.
549. YATES, F. (1946), "A review of recent statistical developments in sampling and sampling surveys", *J.R. Statist. Soc.*, 109, 12-43.
550. YOUNG, C. E. (1946), "Applications and problems of productivity data", *J. Amer. Statist. Ass.*, 41, 421-31.
551. YOUNG, R. A. & HOLTHAUSEN, D. McC. (1947), "Values and limitations of consumer financial surveys for economic research", *Fed. Reserve Bull.*, 33, 244-56.
552. YULE, G. U. (1945), "On a method of studying time-series based on their internal correlations", *J.R. Statist. Soc.*, 108, 208-25.
553. ZEISEL, H. & HARPER, V. E. (1948), "The advertising value of different magazines", *J. Marketing*, 13, 56-61.
554. ZWINGLI, U. (1949), "Die berechnung des schweizerischen volkseinkommens und ihr erkenntniswert", *Schweiz. Z. Volksw. Statist.*, 85, 97-118.
555. (1944), "The American economy in 1943: business inventories", *Surv. Curr. Bus.*, 24, No. 1, 8-10.
556. (1943), "The business situation: business inventories", *Surv. Curr. Bus.*, 23, No. 3, 6-8.
557. (1943), "The business situation: consumer expenditures", *Surv. Curr. Bus.*, 23, No. 4, 7-8.
558. (1947), "Business loans of member banks", Parts 1-5, *Fed. Reserve Bull.*, 33, 253-63, 498-517, 524-7, 664-80, 803-19, 963-77.
559. (1943), *Cost Behavior and Price Policy*, Committee on price determination, conference on price research. New York: National Bureau of Economic Research.
560. (1943), *Credit Buying*, Wartime Social Survey, n.s., No. 23.
561. (1947), "Conjunctuurvoorspellingen in de Verenigde Staaten", *Statist. Econ. Ondzoek.*, 2, 76-82.
562. (1948), "City worker's family budget", *Mon. Lab. Rev.*, 66, and *BLS Bulletin*, No. 927.
563. (1949), "Consumer spending: Denver, Detroit and Houston, 1948", *Mon. Lab. Rev.*, 69, 629-39.
564. (1946), "De economische beteekenis der wasch en strykinrichtingen en der chemische wasscherijen", *Statist. Econ. Ondzoek.*, 1, 24-8.
565. (1946), "Design, size and validation of sample for market research", Committee on marketing research techniques, *J. Marketing*, 10, 221-34.
566. (1947), "De invloed van de prijs van tarwe op het tarweareaal in Nederland, 1924-1939", *Statist. Econ. Ondzoek.*, 2, 113-8.
567. (1947), "De vraag naar enkele tuinbouw produkten, I Druiven", *Statist. Econ. Ondzoek.*, 2, 27-34.
568. (1948 & 1949), "De vraag naar elektrische energie voor huishoudelijk verbruik in de drie grote steden en in Nederland", *Statist. Econ. Ondzoek.*, 3, 30-4 and 4, 144-5.
569. (1946), "The economy in war and transition: a review of 1945", *Surv. Curr. Bus.*, 26, No. 2, 1-9.
570. (1946), "Een statistisch onderzoek naar de veranderingen in de ongelijkheid van de inkomensverdeling", *Statist. Econ. Ondzoek.*, 1, 55-67.
571. (1947), "Eenige aspecten van het economische leven in de Vereenigde Staten na den oorlog", *Statist. Econ. Ondzoek.*, 2, 5-19.
572. (1948), "Enige beschouwingen over steekproeven", *Statist. Econ. Ondzoek.*, 3, 94-101.
573. (1949), "Ekonomiska utredningar våren 1949", *Meddelanden från konjunkturinstitutet* (B: 10), Stockholm, 133-46.
574. (1942), *Food Consumption in the United States, Spring, 1942*. United States Dept. of Agriculture, miscellaneous publication, No. 550.
575. (1949), "Family income and expenditures in 1947", *Mon. Lab. Rev.*, 68 and 69.

1951]

576. (1943), "Income size distributions in the United States", Part 1 (printed), Part 2 (mimeographed) *Conference on Income and Wealth*. New York: National Bureau of Economic Research.
577. (1946), "Income, consumption, and savings", *Surv. Curr. Bus.*, 26, No. 5, 5-7 and 22-4.
578. (1946), "International transactions of the United States during first quarter 1946", *Surv. Curr. Bus.*, 26, No. 7, 16-22.
579. (1946), "Inventory-sales relationships", *Surv. Curr. Bus.*, 26, No. 4, 7-8 and 20.
580. (1947), "Indices van de industriële productie van Nederland. Arbeidsproductiviteit en grondstoffeninvoer na de oorlog", *Statist. Econ. Ondzoek.*, 2, 42-6.
581. (1943 and 1945), "Le développement du commerce extérieur de la Belgique de 1831 à 1939", *Bulletin de Statistique—Institut National de Statistique (Belgium)*, 29, 3-8 and 31.
582. (1945), "Le tourisme étranger en France", *Étud. Conj.*, 3, 43-78.
583. (1949), "La répartition des revenus avant et après la guerre d'après les statistiques fiscales", *Étud. Conj., Union Franç.*, 4, 63-100.
584. (1949), "Limited changes in consumer buying", *Surv. Curr. Bus.*, 29, No. 1, 3-4.
585. (1947), "Manufacturing output", *Surv. Curr. Bus.*, 27, No. 2, 15-8.
586. (1946), "National survey of liquid assets", Parts I-IV, *Fed. Reserve Bull.*, 32, 574-81, 716-22, 844-55 and 965-6.
587. (1946), *National Survey of Liquid Asset Holdings, Spending, and Saving. Part 2: Relation of Saving and Holdings to Income*. Washington, D.C.: United States Department of Agriculture.
588. (1947), "National income and national product", *Surv. Curr. Bus.*, 27, No. 2, 5-10.
589. (1943), *Rural Family Spending and Saving in Wartime*, Bureau of Home Nutrition and Home Economics. Washington, D.C.: United States Department of Agriculture, miscellaneous publication, No. 520.
590. (1947), "Retail sales and consumer income", *Surv. Curr. Bus.*, 27, No. 7, 9-11.
591. (1947), "Representativiteit van steekproeven, bestaande uit de grootste ondernemingen", *Statist. Econ. Ondzoek.*, 2, 82-7.
592. (1948), *Report on an Enquiry into the Family Budgets of Middle Class Employees of the Central Government*. New Delhi: Office of the Economic Adviser to the Government of India.
593. (1948), "Revised estimates of retail sales, 1946-47", *Surv. Curr. Bus.*, 28, No. 1, 7-11.
594. (1949), "Taux, masse, et disparité des salaires en 1949", *Étud. Conj.*, 4, 58.
595. (1947), "1947 survey of consumer finances", Parts 1-4, *Fed. Reserve Bull.*
596. (1948), "1948 survey of consumer finances", Parts 1-5, *Fed. Reserve Bull.*
597. (1949), "1949 survey of consumer finances", Parts 1-8, *Fed. Reserve Bull.*, 35-6, and published separately by Board of Governors, Federal Reserve System.

IV. Economic Classification

1. Collection of Data Concerning Micro-Economic Behaviour

(a) Family budget surveys

13, 24, 25, 38, 46, 47, (60), (68), 70, 85, (90), 125, 152, 175, 176, (191), 212, (235), 242, 247, 248, 249, 264, (272), 287, 308, 309, 311, 314, 316, 317, 356, 380, 389, 426, 435, 436, 446, (453), 477, 504, (506), 527, (549), 551, 560, 562, 563, 573, 574, 575, 576, 586, 587, 589, 592, 595, 596, 597.

(b) Surveys of other economic units

25, 38, 59, (60), (68), 69, 70, (72), (90), (119), 120, 136, 158, 169, 175, 176, (210), 216, (217), 218, 220, 223, 225, 231, (234), (235), 237, 238, 239, (251), (252), 253, (267), (272), 312, 313, 314, 352, 363, 365, 373, (421), 422, (424), 433, 434, 442, (453), 467, (506), (526), 529, (549), 551, 553, 558, (565), 572, 573, 576, 587.

2. Estimation of Size Distributions

(a) Income

38, (60), 70, (90), 124, 136, 164, 212, (272), 330, 358, 385, 576, 589, 595, 596, 597.

(b) Wealth

314, 330, 385, 576, 586, 595, 596, 597.

(c) Consumption

(60), 70, (90), 125, 152, 179, 212, 263, (272), 311, 317, 433, 434, 435, 436, 527, 576, 589, 592, 595, 596, 597.

(d) Production

23, (60), 88, 116, 211, 237, 312, 313, 352, (421), 439, 442, 475, 558, 582.

(e) Taxes

(60), 572.

3. *Estimation of Social Accounting Aggregates*

(a) Income

145, 213, 232, 323, 358, 385, (506), 507, 508, 525, 573.

(b) Wealth

364, 385, 573.

(c) Consumption

213, 460, (506), 507, 508, 525, 573.

(d) Production

158, 292, 573.

(e) Taxes

507.

4. *Graduation, Reliability and Adjustment of Economic Data*

(a) Income

1, 11, 19, 26, 74, 95, (110), 125, 126, 132, 135, 139, 143, 147, 153, 164, 165, (166), 173, 174, (183), 193, 207, 208, 262, 273, 288, 306, 328, 333, 341, 342, 344, 345, 348, 349, 354, 371, (375), 377, 384, 393, 394, 395, 396, 398, 399, 400, (411), (412), 418, 428, 437, 438, 449, 476, 519, (534), 536, 537, 538, 554, 570, 576, 583.

(b) Wealth

19, 143, 301, (412), 576.

(c) Consumption

125, 263, 317, 576.

(d) Production

30, 33, 39, 226, 260, 262, 376.

(e) Taxes

165.

5. *Demand Functions*

(a) Consumers' goods

(i) Consumption as a whole

(2), 21, 22, 29, 31, 32, 38, 41, 48, 51, (62), 76, 82, 91, 101, 107, 113, 127, 137, 138, 146, 170, 171, 176, 182, 184, 187, 188, 201, (202), 204, 205, 221, 222, 229, 265, 280, 283, 302, 303, 308, 309, 315, 316, 317, 323, 336, 337, 343, 347, 356, 366, 367, 368, 403, (407), (408), 420, 441, 445, 450, 451, 452, 459, 462, 468, 472, 478, 479, 492, 498, 512, 519, 523, 540, 545, 546, 547, 548, 557, (561), 569, 571, 577, 585, 588, 590, 593.

(ii) Particular goods

14, 17, 18, 20, (34), 36, 37, 38, 41, 43, 49, 51, (58), 73, 75, 76, 77, (78), 84, 96, 101, 127, 150, 161, 177, 185, 186, 189, 190, 195, (202), 203, 221, 222, 233, 236, 243, 244, (254), 274, 282, 290,

1951]

304, 309, 318, 324, 331, 334, 356, 366, 370, 378, 379, 380, 390, 402, 406, (408), 425, 427, 430, 435, 436, 450, 457, 458, 462, 465, 483, 492, 493, (496), 505, 510, 517, 520, 521, 527, 532, 540, 567, 568, 584, 590.

(b) Producers' goods

50, 51, 156, 160, 227, 278, 279, 320, 332, 350, (401), 402, 406.

(c) Imports and exports

3, 4, 31, 44, 71, 79, 80, 81, 82, 83, (128), 168, 229, 230, 310, 481, 482, 483, 485, 486, 487, 488, 578, 580, 581.

(d) Money and other assets: debts

42, 101, 115, 129, 141, 142, 261, 275, 276, 300, 329, 374, 474, (484), 522.

6. Production, Cost and Supply Functions

(a) Individual firms and industries

(i) Agriculture

5, 16, 20, 57, 118, 154, 158, 162, 185, 220, 223, 228, 255, 305, 312, 335, 351, 353, 381, 390, 391, 419, 425, 429, 455, 472, 479, 490, 493, 524, 530, 566.

(ii) Other industries

50, 53, 54, 63, 86, 117, 148, 159, 236, (241), 250, 256, 307, 325, 357, 397, 404, 413, 443, 447, 473, 502, 509, 513, 515, 516, 528, 550, 559, 564.

(iii) National or whole economy functions

(61), 65, 98, 114, 133, 134, 203, 359, (388), 443, (444), 454, 461, 479, 492, 501, 515, 517, (531).

(b) Labour supply

(166), 294, 328, 405, 479, 502, (514), 535, 543, 571.

(c) Business size, profitability; number of firms

87, 89, 111, 116, 118, 154, 160, 266, 503, 591.

(d) Inter-industry input-output relationships

107, (140), 157, 172, 296, 297, 298.

7. Models of Particular Markets

(a) Consumers' goods markets

326, 369, 410, 533, 555, 556, 579.

(b) Producers' goods markets

(i) Agriculture

15, 20, 96, 97, 102, 219, 245, 326, 372, 416, 470, 472, 479, 492, 493, 499, 512, (544).

(ii) Other

17, 104, 149, 151, 299, 304, 326, 369, 410, 479, 492, 509, 533, 555, 556, 579.

(c) Labour markets

111, 122, 224, 328, 355, 415, 479.

(d) International markets

79, 81, 82, 83, 94, 104, 297, 346, 481, 482, 487, 488, 523, 581.

(e) Financial markets

42, 108, 121, 215, (257), 291, 300, 440, 471, (484).

(f) Market structure and price determination

245, 299, 378, 456, 500, 542.

(g) Economic growth patterns

67, 106, 131, 192, 214, 448.

8. *Explanations of Distribution of Incomes*

(a) Functional

45, (166), 343, 347, 459, 479, 502, 594.

(b) Industrial

35, 45, 103, 130, 144, (178), 347.

(c) Regional

28, 30, 432, 503, 541.

(d) Business financial policy

28, 55, 56, 89, 93, 163, 277, 327, 432, 441, 539, 541, 554.

9. *Interrelations between Government and the Economy*

1, 19, 64, 150, 161, 189, 207, 348, 349, 377, 437, 519.

10. *Business Cycle Models*

6, 7, 14, 32, 40, 51, 66, 92, 113, 149, 151, 159, 180, (181), 194, (197), 206, 232, (240), 243, 246, (258), (268), (269), (270), (271), 280, (281), 293, 320, (321), (322), (339), 347, 360, 362, 369, (382), 409, 416, 423, 431, 463, 466, 480, 485, 488, 489, 492, 494, 501, 502, (511), (514), (518), 543, (552).

11. *Other Economic Relationships*

8, 9, 27, 246, 295, 417, 487, 553.

12. *Index Numbers*

12, 80, 123, 238, 239, 319, 392, 499.

13. *Theoretical and Expository Articles on the Application of Mathematical Statistics to Economics*

6, 7, 10, 50, 51, 52, 99, 105, 109, 112, 155, 167, 172, 194, 196, 198, 199, 200, 209, 259, 281, 284, 285, 286, 289, 292, 338, 339, 340, 360, 361, 362, 379, 383, 386, 387, 390, (407), 408, 414, 453, 463, 464, 466, 469, 476, 483, 485, 491, 495, 496, 497, 499, 500, 517, 549.

V. *Mathematical-Statistical Classification*21. *Measurement of Economic Magnitudes by Sampling Methods*

12, 13, 14, 24, 25, 38, 46, 47, 59, 60, 68, 69, 70, 72, 85, 88, 90, 101, 111, 119, 120, 136, 152, 158, 169, 175, 176, 183, 191, 209, 210, 212, 213, 216, 217, 218, 220, 223, 225, 231, 234, 235, 237, 238, 239, 242, 247, 248, 249, 251, 253, 264, 267, 272, 287, 292, 308, 309, 311, 312, 313, 314, 316, 317, 330, 352, 356, 358, 363, 364, 365, 373, 375, 380, 385, 389, 421, 422, 424, 426, 433, 434, 435, 436, 442, 446, 453, 467, 477, 504, 506, 507, 508, 526, 527, 529, 549, 551, 558, 560, 562, 563, 565, 572, 573, 574, 575, 576, 586, 587, 589, 592, 595, 596, 597.

1951]

22. *Subjective Assessment of Errors of Observation and their Use in the Adjustment of Observations*

125.

23. *Specification of Frequency Distributions of Economic Variables*

1, 8, 11, 19, 23, 26, 30, 33, 38, 39, 45, 67, 70, 74, 90, 95, 103, 106, 108, 110, 116, 123, 124, 126, 131, 132, 136, 139, 143, 144, 145, 147, 153, 164, 165, 166, 173, 174, 176, 178, 179, 192, 193, 207, 208, 211, 212, 214, 226, 237, 252, 257, 260, 262, 263, 273, 288, 295, 301, 306, 311, 312, 313, 314, 317, 323, 333, 341, 342, 344, 345, 348, 349, 352, 354, 371, 376, 377, 378, 384, 385, 392, 393, 394, 395, 396, 398, 399, 400, 409, 411, 412, 418, 428, 433, 437, 438, 439, 448, 449, 471, 475, 476, 506, 509, 519, 534, 536, 537, 538, 554, 570, 572, 576, 582, 583, 589, 592, 595, 596, 597.

24. *Testing Hypotheses Concerning Economic Relationships, Estimation of Parameters and Prediction*(a) *Analyses of variance and co-variance*

5, 15, 38, 66, 92, 109, 135, 180, 181, 206, 215, 223, 225, 228, 250, 277, 285, 339, 357, 360, 362, 372, 404, 424, 435, 436, 447, 456, 460, 463, 490, 492, 516.

(b) *Other applications of classical regression*

2, 3, 4, 5, 6, 7, 8, 9, 16, 17, 18, 20, 21, 22, 27, 28, 29, 30, 31, 32, 33, 35, 36, 37, 38, 40, 41, 42, 43, 44, 48, 49, 54, 55, 56, 57, 58, 61, 62, 63, 64, 65, 66, 71, 73, 75, 76, 77, 79, 80, 81, 82, 83, 84, 87, 89, 91, 93, 94, 96, 97, 98, 99, 101, 102, 104, 107, 112, 113, 114, 115, 117, 118, 121, 122, 127, 128, 129, 130, 133, 134, 137, 138, 140, 141, 142, 146, 148, 149, 150, 151, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 166, 167, 168, 170, 171, 172, 177, 182, 184, 185, 186, 187, 188, 189, 190, 195, 200, 203, 204, 205, 206, 207, 219, 220, 221, 222, 223, 224, 227, 228, 229, 230, 232, 236, 241, 243, 244, 245, 246, 255, 256, 257, 258, 261, 265, 266, 275, 276, 278, 279, 280, 282, 283, 288, 290, 291, 293, 294, 299, 300, 302, 303, 305, 307, 308, 309, 310, 312, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 327, 328, 329, 331, 332, 333, 334, 335, 336, 337, 343, 346, 347, 350, 351, 353, 355, 356, 357, 359, 366, 367, 368, 369, 370, 372, 374, 379, 380, 381, 388, 391, 397, 401, 402, 403, 404, 405, 406, 407, 408, 410, 413, 417, 419, 420, 425, 427, 429, 430, 431, 432, 434, 440, 441, 443, 444, 445, 447, 450, 451, 452, 454, 455, 456, 457, 458, 459, 461, 466, 470, 471, 472, 474, 478, 479, 480, 481, 482, 483, 484, 485, 487, 488, 490, 491, 493, 498, 499, 501, 502, 503, 505, 510, 513, 514, 515, 517, 519, 520, 521, 522, 523, 524, 527, 528, 530, 531, 532, 533, 535, 539, 540, 541, 542, 543, 545, 546, 547, 548, 550, 553, 554, 555, 556, 557, 559, 561, 564, 567, 568, 569, 571, 572, 576, 577, 578, 579, 580, 581, 584, 585, 588, 590, 591, 593, 594.

(c) *Confluence analysis*

50, 51, 53, 65, 92, 99, 180, 181, 233, 274, 304, 338, 355, 379, 390, 414, 415, 462, 465, 483, 486, 512, 566, 567.

(d) *Simultaneous equations*

20, 34, 52, 99, 105, 180, 196, 197, 198, 199, 201, 202, 233, 240, 254, 280, 281, 284, 285, 286, 289, 296, 297, 298, 304, 325, 337, 386, 387, 469, 483, 485, 492, 493, 496, 511, 516.

(e) *Autoregressive single equations*

52, 78, 196, 240, 258, 268, 269, 270, 271, 326, 360, 361, 362, 382, 383, 416, 464, 489, 494, 518, 544, 552.

(f) *Other models*

86, 463, 468, 473, 491, 492, 499, 500, 525.

THE SOURCES AND NATURE OF STATISTICAL INFORMATION IN SPECIAL FIELDS OF STATISTICS

STATISTICS OF THE BRITISH MOTOR INDUSTRY

By C. V. FORD,

*Formerly Statistician to The Society of Motor Manufacturers and Traders, Limited**Introduction*

THE descriptive term the "British motor industry" is one which is capable of widely varying interpretation. In its full significance it connotes a highly complex organization. Apart from the car and commercial vehicle element (including, of course, their parts and accessories) the industry includes, amongst the wide variety of products for which it is responsible, not only such items as agricultural tractors and factory and warehouse trucks, but also trailers, marine engines, transport service equipment and other manufactures.

It is not the purpose of this Paper to present an encyclopaedic mass of material on all sections of the industry, but rather to single out and deal specifically with those products with which, by popular usage, the term is generally associated, namely, cars and commercial vehicles. In themselves, as the student will discover, such statistics offer a wide scope for study, and if they are to be properly interpreted, demand a sound background knowledge of the manufacturing and distributive processes in which motor vehicles are involved.

Of recent years there has been a vast increase in the amount of statistical data available to the industry. An outstanding instance is to be found in the case of information on motor vehicle production. Before the war the only figures consisted of those in the form of estimates of total output made by the Society of Motor Manufacturers and Traders. In 1945 production figures were collated for the first time by the Ministry of Supply, and from then onwards were published officially in the *Monthly Digest of Statistics*, and by the Society, in the breakdown indicated later. The amount of detail in the material which had been published through Governmental sources in the immediate pre-war era was also widely expanded and, as the industry began to take more and more of a share in the shaping of the post-war national economy, so was that material augmented by special returns initiated by the Society for the confidential use and benefit of its Members.

I have divided this Paper into two broad sections, one headed "The Home Market" and the other "The Export Market", since, although there is some inevitable overlap, those are the two main headings into which all statistics relating to the industry can be most conveniently classified. In each Section I have listed the various sets of statistics available, quoting the source, as a preliminary to a full treatment of the data themselves.

In all cases (save where the information is confidential) I have included, not as an Appendix divorced from the text, but as an integral part of the description, an extract from the Society's publications illustrating the way in which the actual details are presented to the industry. I have adopted this method, believing it to be the best means of presenting the material and of explaining and interpreting the purport of the figures.

1951]

The Home Market

The expression the "Home Market"* refers to the United Kingdom.

- (1) Motor Vehicle Production (source: Ministry of Supply).
- (2) Registrations of Motor Vehicles in Great Britain and Northern Ireland (source: Ministry of Transport and Ministry of Commerce respectively).
- (a) New registrations.
- (b) Licences current.
- (3) Employment and earnings.
- (4) Imports of the United Kingdom.
- (5) Relationship between "Production for the Home Market" and "New Registrations".

1. *Motor Vehicle Production*

Output figures refer by no means only to the number of vehicles which emerge from the production lines virtually ready for the road. The form of production may be that of a complete vehicle, or chassis (i.e., the vehicle less bodywork), in both cases either assembled or unassembled. It is for this reason appropriate to regard the statistics in terms of "units".

There are those manufacturers who produce the chassis unit only, the vehicle being completed by a separate firm of bodybuilders. Apart from this practice (which is found in both car and commercial vehicle plants and predominantly so among the factories of the heavier goods and passenger-carrying vehicles), output in chassis form and production of unassembled units are processes demanded by the export trade. This follows the high tariff and other protective measures adopted by many overseas markets against the importation of complete vehicles, imposed for the purpose of safeguarding local employment and industry.

Output is allocated as between the two classes of vehicles, car and commercial, although taxis are included with the car element. Car production is divided into ranges according to the cylinder capacity in cubic centimetres of the engine. Commercial vehicles are shown by carrying capacity groups in the case of goods vehicles, while public service vehicles and trolleybuses (which are not legally included in the former term) and battery electric vehicles each receive separate treatment.

For each class the total output is broken down into "home" and "export" allocation. It is largely this division which so often gives rise to misunderstanding, either because the "home" figure is related to "New Registrations" (as to which see below), or because of an attempt to reconcile the export quota with the figures compiled by Customs and Excise.

The full significance of the natural conflict between these two different sets of figures comes with an appreciation of the way in which they are to be correctly interpreted. In view of the importance of the need to draw the distinction, I have included at the end of this—the Home Market Section—a summary of the main factors in relation to the "home allocation" of production and "new registrations", and at the end of the Export Section a similar summary in connection with the "export allocation" and the Customs and Excise figures. Meanwhile, the numbers shown under each heading must be regarded only as an allocation, i.e., the quantity earmarked by manufacturers at the time of output for ultimate disposal to the home and export markets.

Table 1 shows the form in which the details are published each month by the Society, the actual figures in this case relating to the month of June, 1950, with cumulative totals for 6 months ended June, 1950.

2. *Registration of Motor Vehicles in Great Britain and Northern Ireland*

Registration is necessary under the Vehicles Excise Act, 1949, for Great Britain, and the Roads Act, 1920, for Northern Ireland for all motor vehicles used on public roads (except for certain vehicles operating under an "International Circulation Permit", brought into this country by persons making only a temporary stay), but has not, since September, 1939, been extended to vehicles belonging to the Armed Forces of the Crown.

* Strictly the term includes the Channel Islands and the Isle of Man, for which separate statistics are also available.

The statistics for Great Britain and Northern Ireland are compiled, so far as possible, in terms of the statutory classes for taxation purposes. These groupings sometimes include vehicles other than those of the type to which they predominantly refer. So, the figures relating to cars include certain other vehicles which are taxed at the same rate, for example, dumpers; this "foreign" element, however, is negligible in relation to the total.

Both new registration and licences current statistics are available in great detail, not only as regards the number in each taxation grade for each class of vehicle, but also in a form showing the apportionment as between the various county and county borough licensing authorities.

Licences current are sometimes otherwise described as "total registrations" (a term which is liable to give rise to confusion, since it is equally applicable to any total of new registrations over a given period) or "vehicles in use".

TABLE 1

Motor Vehicle Production

Number of Cars, Commercial Vehicles (including chassis) produced during the month of June, 1950, with comparative weekly average figures for the year 1938, and total for the 6 months ended June, 1950.

Service vehicles have ceased to be separately identified as from January, 1949.

(Statistics compiled from figures furnished by the Ministry of Supply.)

Description of Vehicle	† June, 1950				1938 Weekly Average	‡ 6 Months ended June, 1950		
	Export	Home	Total	Weekly Average		Export	Home	Total
Cars (including taxis):								
Exc. — c.c. not exc. 1,600 c.c.	29,763	4,410	34,173	6,835	No	151,872	26,574	178,446
„ 1,600 „ „ 2,200 „	6,332	2,445	8,777	1,755	details	34,087	11,632	45,719
„ 2,200 „	4,385	2,693	7,078	1,416	available	24,880	13,462	38,342
Total Cars	40,480	9,548	50,028	10,006	6,500*	210,839	51,668	262,507
Commercial Vehicles:								
Goods Vehicles, Road Haulage Tractors and Special-type Vehicles: Carrying Capacity—								
Under 15 cwt.	7,434	3,990	11,424	2,285		43,133	19,702	62,835
15 cwt. and up to 6 tons	7,632	4,318	11,950	2,390		39,620	21,432	61,052
Over 6 tons	184	624	808	161		1,132	2,535	3,667
Total Goods Vehicles, Road Haulage Tractors and Special-type Vehicles	15,250	8,932	24,182	4,836		83,885	43,669	127,554
					No			
					details			
P.S.V.'s and Trolley Buses:					available			
P.S.V.'s:								
Single Deck	342	397	739	148		1,781	2,169	3,950
Double Deck	42	327	369	74		60	2,308	2,368
Trolley Buses	4	24	28	5		48	107	155
Total P.S.V.'s and Trolley Buses	388	748	1,136	227		1,889	4,584	6,473
Battery Electric Vehicles	6	242	248	50		24	863	887
Total Commercial Vehicles	15,644	9,922	25,566	5,113	2,000*	85,798	49,116	134,914
Grand Total Cars and Com- mercial Vehicles	56,124	19,470	75,594	15,119	8,500*	296,637	100,784	397,421

1951]

2(a). *New Registrations*

New registration statistics refer not only to new vehicles, whether British or foreign, but also to used vehicles such as those ex-W.D. stock and those imported after use overseas without having been previously registered in this country.

By special arrangement with the Ministry of Transport, the Society's Statistical Department has been able (since June, 1949) to arrange for the used element to be separately distinguished in the new registration statistics published by the Society. This refinement has been of considerable benefit to the industry since, for the first time, it has enabled what amounts to a virtually accurate analysis to be made of sales of new vehicles on the home market.

The following Tables illustrate the form in which new registration data are published by the Society each month in respect of both classes of vehicle for Great Britain alone. The amount of detail included in the actual published form (in which all vehicles are separately treated) is far too exhaustive to permit of the reproduction of more than an extract. It will be appreciated that this information is separately available for *each* licensing authority, of which there are no less than 185 in Great Britain.

TABLE 2
Registrations of Motor Vehicles

New Registrations

Number of mechanically propelled Road Vehicles registered for the first time under the Vehicles (Excise) Act, 1949, by all Registration Authorities in Great Britain, and the number of mechanically propelled Road Vehicles registered for the first time under the Roads Act, 1920, by all Registration Authorities in Northern Ireland and the Irish Republic, during the month of June, 1950, and totals for the 6 months ended June, 1950.

*Great Britain**Distinguishing Used Vehicles Registered for the First Time*

(Statistics compiled from figures furnished by the Ministry of Transport)

The figures include such used vehicles as are registered for the first time in this country, but exclude certain vehicles operated by the Forces of the Crown and Allied Powers. The number of used vehicles registered as above are included in the main figures and separately distinguished in the figures in italics.

Such vehicles of all classes as are exempt from taxation are not included.

<i>Description of Vehicle</i>		<i>June, 1950</i>			
		<i>Light Oil</i>	<i>Heavy Oil</i>	<i>Electric</i>	<i>Total</i>
<i>Cars:</i>					
Exc.	Not exc.				
— c.c.	700 c.c.	8	—	—	8
700 "	800 "	57	(16)	—	57
800 "	900 "	10	(9)	—	10
900 "	1,000 "	872	(32)	—	872
1,000 "	1,100 "	35	(16)	—	35
3,600 "	3,700 "	585	(24)	—	585
3,700 "	3,800 "	17	(13)	—	17
3,800 "	3,900 "	1	(1)	—	1
3,900 "	4,000 "	208	(18)	—	208
4,000 "	4,100 "	202	(27)	—	202
4,100 "	4,200 "	8	(5)	—	8
4,200 "	4,300 "	83	(2)	—	83
4,300 "	4,400 "	3	—	—	3
4,400 "	4,500 "	5	—	—	5
4,500 "	5,000 "	4	(3)	—	4
5,000 "		18	(10)	3	21
Electric				—	—
<i>Total Cars</i>		<i>10,937</i>	<i>(454)</i>	<i>3</i>	<i>(3)</i>
					<i>10,940</i>
					<i>(457)</i>

TABLE 2—contd.

Description of Vehicle		6 Months ended June, 1950						
		Light Oil		Heavy Oil		Electric		Total
Cars:								
Exc.	Not exc.							
— c.c.	700 c.c.	150	(12)	1	—	—	—	151 (12)
700 "	800 "	221	(40)	—	—	—	—	221 (40)
800 "	900 "	89	(75)	—	—	—	—	89 (75)
900 "	1,000 "	7,616	(235)	—	—	—	—	7,616 (235)
1,000 "	1,100 "	191	(95)	—	—	—	—	191 (95)
3,600 "	3,700 "	1,815	(104)	—	—	—	—	1,815 (104)
3,700 "	3,800 "	64	(54)	—	—	—	—	64 (54)
3,800 "	3,900 "	14	(11)	—	—	—	—	14 (11)
3,900 "	4,000 "	1,430	(76)	1	(1)	—	—	1,431 (77)
4,000 "	4,100 "	1,302	(130)	2	(1)	—	—	1,304 (131)
4,100 "	4,200 "	34	(23)	—	—	—	—	34 (23)
4,200 "	4,300 "	514	(19)	—	—	—	—	514 (19)
4,300 "	4,400 "	25	(8)	—	—	—	—	25 (8)
4,400 "	4,500 "	15	(7)	—	—	—	—	15 (7)
4,500 "	5,000 "	21	(13)	3	(3)	—	—	24 (16)
5,000 "		72	(58)	16	(8)	—	—	88 (66)
Electric						5	(1)	5 (1)
Total Cars		63,959 (2,948)		23 (13)		5 (1)		63,987 (2,962)

TABLE 3

Goods Vehicles

(Comprising Agricultural Vans and Lorries, Showmen's Special Vehicles, Local Authorities' Vehicles, Tower Wagons and Other Goods Vehicles) registered for the first time during the month of June and totals for the 6 months ended June, 1950.

Description of Vehicle		June, 1950						
		Light Oil		Heavy Oil		Electric		Total
Goods Vehicles (unladen weight):								
Exc.	Not Exc.							
— cwt.	12 cwt.	315	(5)	—	—	9	—	324 (5)
12 "	16 "	300	(6)	—	—	7	—	307 (6)
16 "	1 ton	1,790	(50)	—	—	34	—	1,824 (50)
1 ton	1½ tons	818	(20)	—	—	41	—	859 (20)
1½ tons	1¾ "	141	(7)	—	—	9	—	150 (7)
1¾ "	2 "	98	(6)	—	—	2	—	100 (6)
2 "	2½ "	431	(25)	—	—	2	—	433 (25)
2½ "	3 "	316	(36)	1	—	—	—	317 (36)
3 "	3½ "	455	(48)	11	—	—	—	466 (48)
3½ "	4 "	557	(42)	22	—	—	—	579 (42)
4 "	4½ "	567	(99)	112	—	—	—	679 (99)
4½ "	5 "	132	(34)	18	—	—	—	150 (34)
5 "	5½ "	85	(26)	20	(1)	—	—	105 (27)
5½ "	6 "	57	(16)	18	—	1	—	76 (16)
6 "	6½ "	52	(19)	8	—	—	—	60 (19)
6½ "	7 "	55	(16)	36	(5)	—	—	91 (21)
7 "	7½ "	21	(2)	37	(2)	—	—	58 (4)
7½ "	8 "	10	(4)	16	(1)	1	—	27 (5)
8 "	8½ "	2	—	13	—	—	—	15 —
8½ "	9 "	4	(2)	85	(3)	—	—	89 (5)
Total Goods Vehicles		6,206	(463)	397	(12)	106	—	6,709 (475)

1951]

TABLE 3—*contd.*

6 Months ended June, 1950

Description of Vehicle		Light Oil	Heavy Oil	Electric	Total
Goods Vehicles (unladen weight):					
Exc.	Not Exc.				
— cwt.	12 cwt.	1,974 (28)	— —	150 —	2,124 (28)
12 "	16 "	2,230 (97)	— —	112 —	2,342 (97)
16 "	1 ton	10,488 (382)	— —	422 —	10,910 (382)
1 ton	1½ tons	4,875 (129)	— —	411 —	5,286 (129)
1½ tons	1½ "	1,186 (62)	— —	71 —	1,257 (62)
1½ "	1½ "	1,213 (60)	— —	17 —	1,230 (60)
1½ "	2 "	3,573 (264)	— —	17 —	3,590 (264)
2 "	2½ "	2,823 (256)	1 —	12 —	2,836 (256)
2½ "	2½ "	3,775 (365)	23 (1)	3 —	3,801 (366)
2½ "	3 "	4,129 (377)	202 —	3 —	4,334 (377)
3 "	3½ "	4,961 (725)	1,136 (4)	— —	6,097 (729)
3½ "	3½ "	1,022 (194)	222 —	1 —	1,245 (194)
3½ "	3½ "	766 (229)	222 (2)	— —	988 (231)
3½ "	4 "	624 (138)	161 (2)	1 —	786 (140)
4 "	4½ "	521 (143)	212 (8)	— —	733 (151)
4½ "	5 "	410 (92)	354 (16)	2 —	766 (108)
5 "	5½ "	198 (35)	476 (8)	— —	674 (43)
5½ "	6 "	79 (18)	224 (4)	3 —	308 (22)
6 "	6 "	38 (8)	120 (3)	— —	158 (11)
		44 (21)	1,042 (76)	— —	1,086 (97)
Total Goods Vehicles		44,929 (3,623)	4,395 (124)	1,225 —	50,549 (3,747)

2(b). *Licences Current*

Licences are issued for all motor vehicles (except for a number exempt from excise duty), registered under the Acts mentioned in para. 2 (*ante*). Of recent years, except for the intervening period of the war, the number of licences current has been the subject of an annual census covering the "number of mechanically propelled road vehicles for which licences were current at any time during the quarter ended September". Apart from the annual census, a count is also made on the last day of February, May, August and November in each year as on that particular day, though this is compiled in terms of broad vehicle classes, i.e., cars, hackneys, etc., only.

The September census is taken in a form which enables the same detail to be provided for "licences current" as is available for new registration data. Again the data are available for each licensing authority.

3. *Employment and Earnings*

There are no reliable published data for such matters as employment and earnings in the motor industry as such. In 1947 the Society of Motor Manufacturers and Traders carried out a special inquiry in respect of the labour force (manual and clerical) employed in the manufacture of cars and commercial vehicles, and actual returns from manufacturers showed the figures to be in the region of 158,000. This number, however, covered only those located within actual motor vehicle factories, and took no account of labour engaged upon the output of supplies for the industry, tyres, and other finished parts and accessories, quite apart from any question of employment in the unfabricated material sphere. Indeed, the scope to be included when assessing the figure has that element of elasticity which, as I accentuated in the "Introduction" to this Paper, is a natural corollary to the expression the "British motor industry". For all practical purposes, however, employment in the manufacture of cars and commercial vehicles (including their finished component parts) is probably around 250,000. It is not possible to apportion this figure as between the two classes of vehicle separately, by reason of the fact that they may have many a common production line in British plants.

The *Ministry of Labour Gazette*, which publishes an employment figure for wage earners engaged in "the manufacture of motor vehicles and cycles", also shows the average earnings applicable to that group, a level exceeded only by that for certain processes of iron and steel manufacture.

4. Imports of the United Kingdom

Some mention must be made of import statistics, although the post-war era has carried with it what amounts to a virtual ban upon the importation of motor vehicles into this country. Such exceptions as are permitted, e.g., units for assembly, vehicles accompanying individuals as personal property, cars operated by the "Corps Diplomatique", and specially licensed admissions, are recorded according to the detail prescribed in the Import List in the statistics compiled by H.M. Customs and Excise.

Although, through the medium of a special return compiled by that Department for the Society, the import figures are provided in greater detail than those contained in the *Accounts relating to the Trade and Navigation of the United Kingdom*, it is upon the latter document that the Society bases the monthly information which it issues, as follows:

TABLE 4
Imports of the United Kingdom

For the month of June, 1950, and total for the 6 months ended June, 1950
(Statistics compiled from figures officially published by the Board of Trade)

Description	June, 1950		* 6 Months ended June, 1950	
	No.	£	No.	£
Cars and Taxis—new	7	4,009	49	38,579
Tractors:				
Tracklayers, all types	17	19,021	142	339,184
Agricultural, wheeled	12	8,595	56	37,639
All other Motor Vehicles except Motor Cycles and Tricars	260	107,765	1,586	583,784
Chassis—All Motor Vehicles	85	21,744	663	114,287
Parts and Accessories of Motor Vehicles except Motor Cycles and Tricars:				
Tyre Outer Covers	768	5,456	5,691	40,915
Engines	—	75,037	—	254,610
Other Parts and Accessories†	—	278,361	—	1,835,614

* Includes adjustments made to date.

† This item excludes inner tubes for tyres, accumulators, magnetos, electric bulbs, ball and roller bearings and sparking plugs.

5. Relationship between "Production for the Home Market" and "New Registrations"

There exists between these sets of figures a difference in time, apart from the lag between manufacture and actual registrations, in that the former relates to the production phase, the "monthly" accounting period for which varies between four and five weeks, while the registration figures cover a calendar month. Other reasons for the lack of any real accord between these statistics are (*inter alia*) as follows:

(1) Production figures relate to the United Kingdom, hence registrations (including the appropriate "exempt" class) in Northern Ireland and the Isle of Man must be taken into account.

(2) "Home deliveries" (in the case of cars)—cars bought by overseas buyers from the export quota of production—may be registered and used by them in this country for a period not exceeding twelve months prior to shipment unless purchase tax is to become payable.

(3) Car production figures include an element of taxis, later registered as "Hackneys", and of chassis which will ultimately be fitted with van bodies and registered in the "goods vehicle" class.

(4) Registration figures include certain used vehicles (separately identifiable in the Society's published data), certain imported vehicles and others not of the type to which the figures predominantly refer (see above).

1951]

The Export Market

- (1) Production for Export (source: Ministry of Supply).
- (2) Exports of the United Kingdom (source: H.M. Customs and Excise).
- (3) Registrations of Motor Vehicles Overseas (mainly H.M. Government representatives and the overseas representatives of the S.M.M.T.):

- (a) new registrations;
- (b) total operation.

- (4) Relationship between "Production for Export" and "Actual Exports".

1. Production for Export

The composition of the motor vehicle "unit" for the purpose of the compilation of production figures and general comment upon the form in which output details are published are dealt with above under the heading "Motor Vehicle Production". Beyond drawing attention to the remarks made above regarding the need for caution in the interpretation of the figures shown under "export" in the Table, there is nothing that can be usefully added at this stage. The fundamental differences between the export allocation as shown in production data, from the particulars compiled by H.M. Customs and Excise, are discussed on the following page.

TABLE 5

Extract from Form Showing Exports of the United Kingdom

For the month of June, 1950, and total for the 6 months ended June, 1950
(Table condensed by omitting certain items indicated by "Etcetera" and asterisks)

Description	June, 1950		* 6 Months ended June, 1950	
	No.	£	No.	£
Cars and Taxis (New):				
Not exceeding 1,000 c.c.—				
Assembled	2,473	612,518	13,738	3,465,132
Unassembled	1,062	214,881	4,871	971,989
Chassis	234	30,737	2,731	333,737
Etcetera	*	*	*	*
Exceeding 3,500 c.c.—				
Assembled	958	582,543	5,521	3,459,264
Unassembled	42	20,272	457	209,711
Chassis	13	8,008	47	32,126
Total	1,013	610,823	6,025	3,701,101
Total Cars and Taxis	36,284	10,190,311	203,626	59,163,208
Division by Type:				
Assembled	22,949	7,516,366	141,763	46,592,708
Unassembled	7,587	1,761,352	33,644	7,982,346
Chassis	5,748	912,593	28,219	4,588,154
Total	36,284	10,190,311	203,626	59,163,208
Division of Trade:				
British Commonwealth and Empire and Irish Republic—				
Complete	20,548	6,200,493	124,074	38,375,744
Chassis	5,399	837,976	25,708	4,088,195
Foreign Countries—				
Complete	9,988	3,077,225	51,333	16,199,310
Chassis	349	74,617	2,511	499,959
Total	36,284	10,190,311	203,626	59,163,208

TABLE 5—*contd.*

Description	June, 1950		* 6 Months ended June, 1950	
	No.	£	No.	£
Commercial Vehicles (New):				
Delivery Vans and Dual Purpose Vehicles (Utilities)	6,381	1,930,587	35,296	10,701,890
Goods Vehicles:				
Unladen Weight—				
Complete:				
Not exceeding 3 tons	233	122,280	1,094	536,447
Exceeding 3 tons—				
With Diesel and similar engines	10	24,094	96	202,928
Etcetera	*	*	*	*
P.S.V.'s and Trolley Buses:				
P.S.V.'s—				
Complete:				
Single deck	21	59,357	138	453,975
Double deck	—	—	4	18,129
Etcetera	*	*	*	*
Tractors—Road Haulage	73	79,451	288	279,717
Other Descriptions:				
Complete	139	145,138	829	1,286,468
Chassis	27	21,752	127	81,859
Total	14,235	5,843,713	72,657	30,237,445
Dumpers and Dump Trucks	59	69,499	324	475,390
Total Commercial Vehicles	14,294	5,913,212	72,981	30,712,835
<i>Division of Trade (excluding Dumpers and Dump Trucks):</i>				
British Commonwealth and Empire and Irish Republic—				
Complete	4,224	1,437,775	22,376	7,770,491
Chassis	5,628	2,503,425	25,343	11,446,186
Foreign Countries—				
Complete	2,666	993,884	15,609	6,129,356
Chassis	1,717	908,629	9,329	4,891,412
Total	14,235	5,843,713	72,657	30,237,445

2. Exports of the United Kingdom

Details of exports as compiled by Customs and Excise are utilized for the motor industry, first in the summary form provided by the *Accounts Relating to the Trade and Navigation of the United Kingdom* each month, and later in the shape of a special return containing all the detail set out in the official Export List for the required headings. As in the case of Imports, the information published monthly by the Society is based upon the Trade Accounts, though the more comprehensive particulars are issued in other publications of the Society.

It has become common practice, when referring to these statistics in so far as they concern motor vehicles, to use the term "actual exports" by way of differentiating between them and the "export allocation" element of production data. While this term serves the immediate purpose of creating a distinction, it is nevertheless inaccurate in its true sense. This is made clear by the note headed "Period of Return" in the explanatory note section to the *Monthly Accounts*, and is, of course, an element common to all the items in the publication.

Even the monthly summary now contains a wealth of detail, much of which has been included on representations made by the Society, and just as in the case of registrations, the data is such as to permit the reproduction in this Paper of a mere extract from the actual material issued by the Society.

1951]

In the case of cars, the detail is separated into various groups of cylinder capacity, each subdivided by the three main forms of "unit" concerned, namely, "assembled", "unassembled", and "chassis". Commercial vehicles, however, are treated on the basis of "type", separately identifying the complete unit (assembled or unassembled), and chassis. In both cases volume and value are quoted.

The *Monthly Trade Accounts* also provide the material for a "Destination Summary" on a motor vehicle unit basis for both cars and commercial vehicles, "summary" in the sense that not all destinations are separately specified nor, even for those listed, is the full detail shown for complete or chassis against those countries whose imports are small.

Tables 5 and 6 show extracts from the form in which the Society circulates export data, both for motor vehicle units in the available detail and for destination purposes.

3. Registrations of Motor Vehicles Overseas

The Society has set up world-wide machinery for the regular receipt of information on the score of motor vehicle registrations, both "new", i.e., vehicles put into circulation for the first time over a given period, and "total"—the aggregate number in operation at a given date. From many territories the data are provided in considerable detail, e.g., in horse-power, weight or other

TABLE 6

Extract from Form of Table Showing Destination Summary of U.K. Exports of Cars, Commercial Vehicles, Chassis and Agricultural Tractors

For the month of June, 1950, and total for the 6 months ended June, 1950

(Table condensed by omitting certain items denoted by "Etcetera" and asterisks)

Cars and Taxis (New) Exported to:—	June, 1950			
	Complete		Chassis	
	No.	£	No.	£
British Commonwealth and Empire, Irish Republic:				
Australia	5,749	2,146,640	4,812	728,275
New Zealand	1,075	263,205	567	105,372
Africa: British East	294	97,787		
British West	264	94,923		
Etcetera	*	*	*	*
Other Commonwealth Countries	124	41,803		
Irish Republic	624	150,450		
Total	20,548	6,200,493	5,399	837,976
Foreign Countries:				
Chile	Included in "Other Foreign Countries"		12	2,655
Argentina	1	357		
Austria	65	23,173		
Belgium	1,347	414,229		
Etcetera	*	*	*	*
Other Foreign Countries	601	216,700		
Total	9,988	3,077,225	349	74,617
Total Cars and Taxis	30,536	9,277,718	5,748	912,593
	No.		£	
	36,284		10,190,311	
Percentage of Total Cars and Taxis to British Commonwealth and Empire and Irish Republic	67.3	66.8	93.9	91.8

TABLE 6—contd.

Cars and Taxis (New) Exported to:—		* 6 Months ended June, 1950			
		Complete		Chassis	
		No.	£	No.	£
British Commonwealth and Empire, Irish Republic:					
Australia		46,701	17,097,119	23,404	3,629,963
New Zealand		6,788	1,707,743	1,968	389,570
Africa: British East		1,739	576,712		
British West		1,175	416,054		
Etcetera		*	*	*	*
Other Commonwealth Countries		1,067	359,529		
Irish Republic		3,980	1,004,868		
Total		124,074	38,375,744	25,708	4,088,195
Foreign Countries:					
Chile		Included in "Other Foreign Countries"		27	6,066
Argentina		32	17,523		
Austria		454	172,712		
Belgium		7,273	2,183,543		
Etcetera		*	*	*	*
Other Foreign Countries		3,277	1,180,951		
Total		51,333	16,199,310	2,511	499,959
Total Cars and Taxis		175,407	54,575,054	28,219	4,588,154
		No.	£	No.	£
		203,626		59,163,208	
Percentage of Total Cars and Taxis to British Commonwealth and Empire and Irish Republic		70.7	70.3	91.1	89.1

Commercial Vehicles (New) Exported to:—		June, 1950			
		Complete		Chassis	
		No.	£	No.	£
British Commonwealth and Empire, Irish Republic:					
Africa: British East		320	136,221	307	145,849
British West		144	68,216	357	149,716
Southern Rhodesia		117	46,972	25	35,119
Etcetera		*	*	*	*
Other Commonwealth Countries		167	65,153	246	123,421
Irish Republic		98	27,774	20	11,195
Total		4,224	1,437,775	5,628	2,503,425
Foreign Countries:					
Argentina		42	75,598	—	—
Belgium		329	90,752	381	156,957
Brazil		185	86,106	148	102,596
Denmark		98	21,178	90	30,809
Etcetera		*	*	*	*
Norway		Included in "Other Foreign Countries"		105	53,350
Uruguay				38	15,709
Other Foreign Countries		567	239,604	100	54,664
Total		2,666	993,884	1,717	908,629
Total Commercial Vehicles		6,890	2,431,659	7,345	3,412,054
		No.	£	No.	£
		14,235		5,843,713	
Percentage of Total Commercial Vehicles to British Commonwealth and Empire and Irish Republic		61.3	59.1	76.6	73.4
Grand Total Cars (inc. Taxis) and Commercial Vehicles		37,426	11,709,377	13,093	4,324,647
		No.	£	No.	£
		50,519		16,034,024	
Percentage of Grand Total Cars (inc. Taxis) and Commercial Vehicles to British Commonwealth and Empire and Irish Republic		66.2	65.2	84.2	77.3

1951]

TABLE 6—contd.

<i>Commercial Vehicles (New) Exported to:—</i>		<i>* 6 Months ended June, 1950</i>			
		<i>Complete</i>		<i>Chassis</i>	
		<i>No.</i>	<i>£</i>	<i>No.</i>	<i>£</i>
British Commonwealth and Empire, Irish Republic:					
Africa: British East		1,477	629,534	1,090	551,845
British West		608	308,446	1,858	789,730
Southern Rhodesia		623	297,772	176	160,769
Etcetera		*	*	*	*
Other Commonwealth Countries		840	444,061	1,061	497,358
Irish Republic		508	148,651	393	252,083
Total		22,376	7,770,491	25,343	11,446,186
Foreign Countries:					
Argentina		179	566,964	—	—
Belgium		2,753	746,109	1,645	717,338
Brazil		1,403	499,224	536	365,581
Denmark		495	140,980	790	315,506
Etcetera		*	*	*	*
Norway		Included in "Other		332	176,393
Uruguay		Foreign Countries"		598	341,762
Other Foreign Countries		3,212	1,304,391	1,041	582,020
Total		15,609	6,129,356	9,329	4,891,412
Total Commercial Vehicles		37,985	13,899,847	34,672	16,337,598
		<i>No.</i>		<i>£</i>	
		72,657		30,237,445	
Percentage of Total Commercial Vehicles to British Commonwealth and Empire and Irish Republic		59·0	56·0	73·1	70·0
Grand Total Cars (inc. Taxis) and Commercial Vehicles		213,392	68,474,901	62,891	20,925,752
		<i>No.</i>		<i>£</i>	
		276,283		89,400,653	
Percentage of Grand Total Cars (inc. Taxis) and Commercial Vehicles to British Com- monwealth and Empire and Irish Republic		68·6	67·4	81·2	74·2

classes, though the main basis of compilation is that of individual makes for both cars and commercial vehicles. So complete a record system was made possible only as a result of the full and willing co-operation of the Board of Trade. Regular returns, mainly on a quarterly basis for new registrations, and yearly for "total" figures, are now rendered for all overseas territories where administrative resources make the collection of the figures possible. These returns are provided by overseas government offices, and (to some extent) from the overseas representatives of the Society covering Australia, India, Burma and Ceylon, New Zealand, South Africa and Rhodesia, North America, South America, and the Middle East.

In order to achieve uniformity in the interpretation of the terms "cars" and "commercial vehicles", overseas sources of returns were advised by the Society as follows:

- (1) "Cars" to be taken to include taxis, and all such vehicles employed on Governmental or Municipal services.
- (2) "Commercial Vehicles" to be taken to comprise all mechanically-propelled road vehicles of a load-carrying type, buses, trolley-buses, coaches, road haulage (not agricultural) tractors, and special type vehicles such as ambulances, fire engines, etc., including all such vehicles employed on Governmental or Municipal services.

The same form of return is adapted to meet the requirements of both sets of registration figures, the only variation being the heading to the figures column, namely, whether new registrations or "in use". The figures for new registrations in any particular market will not be comparable with the volume of exports over any given period, not only because of the time lag between shipment and sale, but also, for example, because of the further processing of the motor vehicle unit overseas in the case of shipments for local assembly and of chassis requiring body fitment. An extract from the stereotyped form for both cars and commercial vehicles is set out below in Table 7.

4. Relationship between "Production for Export" and "Actual Exports"

The first element of distinction to be made between the above sets of figures is that to which attention has already been drawn above, namely that the "production for export" data relate to the initial output phase where vehicles are allocated *ex* factory lines, the number of which are aggregated for the production Table over a "monthly" accounting period varying between four and five weeks. The "time lag" then intervenes between allocation and shipment as recorded in the Customs and Excise figures, which themselves relate to aggregation of all those shipping documents *received* in the office of the Department during a calendar month, and not, therefore, to the actual exports effective during the period.

TABLE 7

Extract from Form of Table Showing Overseas Registration of Cars

OVERSEAS REGISTRATION SERVICE Issued—August, 1950		Territory—CHANNEL ISLANDS Market—Guernsey During 3 months ended June, 1950	
	New Sales		New Sales
British U.K.:		U.S.A. and Canadian:	
A.C.	—	Buick	—
Allard	—	Cadillac	—
Alta	—	Chevrolet	—
Alvis	1	Chrysler	—
Armstrong-Siddeley	—	Crosley	—
Aston-Martin	—	De Soto	—
Austin	3	Dodge	—
Bentley	—	Ford	—
Bristol	—	Frazer	—
Daimler	—	Hudson	—
Ford	2	Kaiser	—
Frazer-Nash	—	Lincoln	—
Etcetera	*	Etcetera	*
Total British U.K.	61		
		French:	
Austrian:		Bugatti	—
Austro-Daimler	—	Citröen	1
Puch	—	Delage	—
Steyr	—	Delahaye	—
Other Makes	—	Ford	—
Total Austrian	—	Hotchkiss	—
		Panhard	—
		Peugeot	—
		Renault	2
		Rovin	—
Belgian:		Salmson	—
Imperia	—	Simca	—
Minerva	—	Talbot-Darracq	—
Other Makes	—	Other Makes	—
Total Belgian	—	Total French	3
		German:	
		Benz	—
		Borgward	—
		D.K.W.	—
		Ford	—
		Hansa	—
		Mercedes	—
		Opel	—
		Volkswagen	—
		Wanderer	—
		Other Makes	—
		Total German	—
		Etcetera	*
		Other Producing Countries	—
		Grand Total	64
		REMARKS:	

1951]

TABLE 7—contd.

Commercial Vehicles

OVERSEAS REGISTRATION SERVICE Issued—August, 1950		Territory—UNION OF SOUTH AFRICA Market—Natal During 3 months ended March, 1950	
	New Sales		New Sales
British U.K.:		U.S.A. and Canadian:	
A.E.C. & A.C.L.O.	—	Autocar	—
Albion	—	Brockway	—
Atkinson	—	Chevrolet	50
Austin	—	Diamond T	—
Bedford	4	Divco	—
Bradford	—	Dodge	30
Bristol	—	Fargo	32
Commer	—	Federal	—
Crossley	—	Ford	74
Daimler	—	F.W.D.	—
Dennis	—	G.M.C.	10
E.R.F.	—	Hudson	—
Foden	—	International	6
Etcetera	*	Etcetera	*
		French:	
		Peugeot	—
		Renault	—
		Rochet-Schneider	—
		Saurer	—
		Simca	—
		Somua	—
		Unic	—
		Willème	—
		Other Makes	—
		Total French	—
		Belgian:	
		Brossel	—
		F.N.	—
		Miesse	—
		Minerva	—
		Other Makes	—
		Total Belgian	—
		Czechoslovakian:	
		Aero	—
		Java	—
		Praga	—
		Skoda	—
		Tatra	—
		Other Makes	—
		Total	—
		Czechoslovakian	—
		German:	
		Benz	—
		Borgward	—
		Etcetera	*
		Scania-Vabis	—
		Volvo	—
		Other Makes	—
		Total Swedish	—
		Swiss:	
		Berna	—
		Saurer	—
		Other Makes	—
		Total Swiss	—
		Other Producing Countries	—
		Grand Total	278

Other reasons for discrepancies between the two sets of figures are (*inter alia*) as follows:

- (1) "Home deliveries" (in the case of cars)—cars bought by overseas buyers from the export quota of production—may be registered and used in this country for a period not exceeding twelve months prior to shipment unless purchase tax is to become payable.
- (2) The inclusion in Customs and Excise figures of the "Channel Islands"—part of the home market from a point of view of deliveries—as an export destination.
- (3) In the case of commercial vehicles the inclusion in Customs and Excise figures of pedestrian controlled delivery vans, vehicles not encompassed in motor vehicle production data.

Bibliography

- The Motor Industry of Great Britain.* London: Society of Motor Manufacturers and Traders, Ltd.
Monthly Statistical Review. London: Society of Motor Manufacturers and Traders, Ltd.
Accounts Relating to the Trade and Navigation of the United Kingdom. London: H.M.S.O.
Monthly Digest of Statistics. London: H.M.S.O.
Ministry of Transport Returns—Mechanically Propelled Road Vehicles Great Britain. London: H.M.S.O.

WHOLESALE PRICES IN 1950
BY THE EDITOR OF "THE STATIST"

TABLE I

THE STATIST'S *Annual Index Numbers* (in continuation of *Sauerbeck's figures*) (1867-77 = 100)

Year	Average No.	Year	Average No.	Year	Average No.	Year	Average No.	Year	Average No.
1950	324	1928	119	1907	80	1886	69	1865	101
'49	274	'27	122	'06	77	'85	72	'64	105
'48	260	'26	125	'05	72	'84	76	'63	103
'47	230	'25	136	'04	70	'83	82	'62	101
'46	186	'24	139	'03	69	'82	84	'61	98
'45	164	'23	128	'02	69	'81	85	'60	99
'44	160	'22	131	'01	70	'80	88	'59	94
'43	155	'21	155	'00	75	'79	83	'58	91
'42	151	'20	251	1899	68	'78	87	'57	105
'41	142	'19	206	'98	64	'77	94	'56	101
'40	128	'18	192	'97	62	'76	95	'55	101
'39	94	'17	175	'96	61	'75	96	'54	102
'38	90	'16	136	'95	62	'74	102	'53	95
'37	102	'15	108	'94	63	'73	111	'52	78
'36	88	'14	85	'93	68	'72	109	'51	75
'35	83	'13	85	'92	68	'71	100	'50	77
'34	81	'12	85	'91	72	'70	96	'49	74
'33	78	'11	80	'90	72	'69	98	'48	78
'32	79	'10	78	'89	72	'68	99	'47	95
'31	82	'09	74	'88	70	'67	100	'18	159*
'30	96	'08	73	'87	68	'66	102	'10	171*
'29	114								

* Jevons's numbers adjusted.

TABLE II

THE STATIST'S *Annual Index Numbers—ten-year averages* (1867-77)

1848-1857 = 89	1900-1909 = 73	1915-1924 = 162	1930-1939 = 88
'58- '67 = 99	'01- '10 = 73	'16- '25 = 165	'31- '40 = 91
'68- '77 = 100	'02- '11 = 74	'17- '26 = 164	'32- '41 = 97
'78- '87 = 79	'03- '12 = 76	'18- '27 = 159	'33- '42 = 104
'88- '97 = 67	'04- '13 = 77	'19- '28 = 152	'34- '43 = 111
'90- '99 = 66	'05- '14 = 79	'20- '29 = 142	'35- '44 = 119
'91-1900 = 66	'06- '15 = 82	'21- '30 = 127	'36- '45 = 127
'92- '01 = 66	'07- '16 = 88	'22- '31 = 120	'37- '46 = 137
'93- '02 = 66	'08- '17 = 98	'23- '32 = 115	'38- '47 = 150
'94- '03 = 66	'09- '18 = 110	'24- '33 = 110	'39- '48 = 167
'95- '04 = 67	'10- '19 = 123	'25- '34 = 104	'40- '49 = 185
'96- '05 = 68	'11- '20 = 146	'26- '35 = 99	'41- '50 = 204
'97- '06 = 70	'12- '21 = 148	'27- '36 = 95	
'98- '07 = 71	'13- '22 = 153	'28- '37 = 93	
'99- '08 = 72	'14- '23 = 157	'29- '38 = 90	

1951]

Monthly Fluctuations of the Index Numbers * of 45 Commodities, 1867-77 = 100

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1898 .	62.8	63.4	63.0	65.5	66.4	64.7	64.3	64.0	63.9	63.6	63.9	63.8	64
1901 .	72.2	71.7	71.0	70.6	70.5	69.8	69.5	69.8	69.6	69.6	69.0	68.4	70
1904 .	70.4	70.8	70.8	70.5	69.9	69.4	69.9	70.4	70.7	71.0	71.2	70.9	70
'05 .	71.2	71.4	71.8	72.0	71.7	72.0	72.5	72.3	72.4	73.2	74.2	74.9	72
'06 .	75.2	75.0	75.7	76.5	77.0	76.9	76.4	76.7	77.5	78.5	78.6	79.7	77
'07 .	80.0	80.7	80.0	80.7	82.4	82.0	81.1	79.4	79.1	78.8	76.7	76.2	80
'08 .	76.0	74.5	74.1	73.8	73.6	72.9	73.1	72.2	72.5	72.2	72.2	72.3	73
1909 .	72.0	71.9	72.4	74.3	75.4	75.1	75.2	74.9	74.7	75.2	75.5	76.3	74
'10 .	77.1	78.1	79.1	78.5	78.2	76.9	78.1	78.2	77.6	77.2	77.8	77.9	78
'11 .	78.5	78.6	78.9	80.0	80.3	80.0	78.9	79.5	80.3	80.7	80.6	80.9	80
'12 .	81.8	82.9	84.4	85.0	85.3	85.5	86.5	85.9	86.7	85.8	85.3	86.4	85
'13 .	86.4	86.1	86.7	86.2	85.7	84.1	84.2	85.0	85.7	84.5	83.3	83.8	85
1914 .	83.5	83.8	82.8	82.3	82.3	81.2	82.4	87.9	89.3	89.8	88.8	91.6	85
'15 .	96.4	100.9	103.7	105.9	107.2	106.4	106.4	107.0	107.8	110.0	113.1	118.4	108
'16 .	123.6	127.0	130.4	134.2	135.4	131.0	130.5	134.5	134.4	141.5	150.8	154.3	136
'17 .	159.3	164.0	169.0	173.0	175.0	180.4	176.9	175.7	176.4	180.6	182.9	185.1	175
'18 .	186.2	187.3	188.0	189.8	191.1	192.3	192.9	195.9	197.1	197.8	195.3	196.0	192
1919 .	192.1	187.5	184.7	184.6	194.6	199.4	206.4	212.7	214.8	224.3	231.0	235.2	206
'20 .	245.3	260.4	261.8	266.1	260.0	255.7	254.6	253.5	248.7	239.9	223.8	207.2	251
'21 .	197.2	183.0	177.2	169.8	162.2	155.8	158.2	154.3	149.4	138.4	136.7	133.6	155
'22 .	132.5	132.2	133.3	134.8	135.5	135.6	134.0	129.6	127.9	130.1	130.6	129.1	131
'23 .	130.2	131.9	132.7	134.0	132.2	127.9	124.8	125.0	127.8	127.7	132.4	133.2	128
1924 .	137.2	138.8	137.0	136.8	136.4	136.3	138.4	138.0	141.3	146.1	145.5	147.7	139
'25 .	144.8	143.1	140.1	137.5	135.7	131.2	134.3	134.3	132.7	130.2	132.9	130.4	136
'26 .	129.3	127.9	126.1	125.5	125.7	124.9	126.0	127.0	128.0	131.0	130.8	123.9	125
'27 .	123.1	124.1	123.6	123.3	123.8	123.1	122.0	122.8	121.5	120.6	121.5	121.4	122
'28 .	120.9	121.1	123.6	125.6	126.2	122.6	120.3	118.0	116.8	116.8	117.9	117.9	119
1929 .	117.0	120.1	120.5	116.5	113.0	113.1	115.2	113.9	112.6	111.1	108.3	108.8	114
'30 .	106.6	104.8	103.0	101.5	98.8	95.8	94.4	92.2	90.8	90.4	88.6	86.9	96
'31 .	85.7	85.5	85.5	84.4	82.2	82.6	80.2	79.1	80.7	82.3	83.0	85.4	82
'32 .	84.7	86.7	84.1	82.5	80.2	77.0	78.9	80.7	80.4	77.8	77.9	77.7	79
'33 .	77.8	77.0	77.0	78.5	80.9	81.3	81.7	81.2	80.7	80.5	79.3	80.0	78
1934 .	82.5	82.5	82.2	81.0	81.1	80.7	82.4	83.4	82.1	81.1	81.0	82.8	81
'35 .	83.6	83.4	82.9	84.1	85.2	83.7	84.3	84.1	85.1	85.8	86.3	86.7	83
'36 .	87.1	87.1	86.7	86.2	85.6	84.8	87.1	89.0	90.4	91.7	94.5	98.9	88
'37 .	99.6	102.1	107.3	104.7	106.2	104.7	105.9	104.4	103.3	100.8	96.7	97.3	102
'38 .	96.5	96.4	94.2	93.5	91.4	91.4	91.1	88.6	88.6	88.8	87.4	89.1	90
1939 .	88.7	88.6	89.0	90.5	90.6	90.6	88.7	90.4	99.7	105.8	112.2	120.1	94
'40 .	124.1	124.5	123.4	126.0	128.0	130.0	129.5	131.5	131.6	131.8	132.7	134.5	128
'41 .	134.9	136.3	138.0	141.1	143.5	144.4	145.3	145.1	145.5	143.7	145.5	146.5	142
'42 .	148.6	153.4	153.5	154.5	156.6	154.4	150.0	149.4	149.7	150.4	151.3	152.2	151
'43 .	153.3	153.2	154.0	154.9	155.6	155.4	156.0	154.4	154.6	153.7	153.9	153.9	155
1944 .	154.9	155.1	155.7	157.9	159.5	160.0	161.9	161.5	160.1	159.6	160.3	160.7	160
'45 .	161.4	161.5	162.1	162.4	164.0	166.7	165.2	163.3	162.7	162.7	162.7	163.2	164
'46 .	165.6	166.2	166.6	168.4	169.3	169.7	174.4	175.7	180.5	196.2	198.1	200.5	186
'47 .	206.7	209.6	212.1	215.9	216.5	218.1	223.4	225.9	228.9	236.0	240.8	246.5	230
'48 .	250.5	253.4	256.0	256.4	260.0	263.9	260.4	260.1	258.1	261.5	263.8	266.0	260
'49 .	267.6	266.8	265.4	272.0	269.2	267.2	263.3	262.5	285.7	291.5	293.7	297.4	274
'50 .	300.2	301.0	301.7	305.2	308.3	310.3	317.7	332.1	335.7	349.2	363.1	372.3	324
'51 .	404.8	420.5	419.3	425.7	420.6								

* The average of the twelve monthly figures of each year does not necessarily coincide with the annual figures, as the latter are calculated mostly from the average of 52 weekly quotations, while the former are based on end-of-the-month prices.

Summary of Index Numbers. Groups of Articles, 1867-77 = 100.

	Vegetable Food (Corn, etc.)	Animal Food (Meat, etc.)	Sugar, Coffee, and Tea	Total Food	Minerals	Textiles	Sundry Materials	Total Materials	Grand Total	Silver*	Wheat Harvest †	Average Price of Consols ‡	Average Bank of England Rate ‡
1873	106	109	106	107	141	103	106	114	111	97.4	80	£ 92½	% 4.750
1896	53	73	59	62	63	54	63	60	61	50.5	112	110½	2.483
1911	70	90	61	75	93	76	81	83	80	40.4	110	79½	3.467
1919	179	213	147	185	220	228	219	222	206	85.3	98	54½	5.166
1922	107	184	82	130	142	134	122	131	131	51.6	105	56½	3.692
'23	98	162	101	122	155	140	115	133	128	49.4	105	57½	3.496
'24	119	158	105	130	158	170	119	145	139	50.7	107	56½	4.0
'25	118	162	89	128	154	165	117	142	136	52.5	114	56½	4.575
'26	108	150	88	119	154	133	112	130	125	47.1	99	54½	5.0
1927	108	138	83	114	141	131	116	127	122	42.8	109	54½	4.650
'28	107	142	78	114	123	136	114	123	119	44.0	109	55½	4.5
'29	99	146	72	110	126	122	108	117	114	40.2	114	54½	5.508
'30	77	142	54	96	112	84	94	96	96	29.0	99	56	3.4
'31	68	119	50	83	100	63	81	80	82	20.4	99	55½	3.975
1932	72	105	50	79	99	64	78	80	79	19.5	105	66½	3.017
'33	60	106	47	74	107	67	76	82	78	18.7	114	73½	2.0
'34	63	108	50	77	109	72	76	84	81	20.0	120	80½	2.0
'35	66	107	42	76	112	80	79	88	83	26.4	112	86½	2.0
'36	76	109	41	81	118	83	84	93	88	18.5	100	85½	2.0
1937	93	117	49	93	142	93	98	109	102	18.4	99	76½	2.0
'38	81	111	43	84	136	75	83	95	90	17.6	122	74½	2.0
'39	74	115	47	83	137	93	88	102	94	17.1	112	66½	2.5
'40	112	141	58	111	167	149	117	140	128	17.1	108	72½	2.0
'41	140	142	65	125	181	162	131	154	142	18.0	109	79½	2.0
1942	170	148	66	140	184	163	142	160	151	18.1	123	82½	2.0
'43	156	156	72	138	187	166	156	167	155	18.1	123	80½	2.0
'44	152	156	73	137	197	182	161	178	160	18.1	121	80½	2.0
'45	155	156	78	139	209	189	159	182	164	23.1	—	87½	2.0
'46	155	154	88	140	239	231	198	219	186	36.7	—	95½	2.0
'47	191	149	100	156	304	295	263	284	230	33.3	—	89½	2.0
'48	217	155	107	171	368	348	279	324	260	34.1	—	78½	2.0
'49	240	185	151	201	382	356	273	328	274	32.8	—	73½	2.0
'50	268	204	224	235	416	491	299	390	324	33.7	—	—	2.0
Average													
1904-13	68	91	53	73	95	74	76	81	77	44.1	106	82½	3.733
1890-99	61	80	63	68	71	56	66	64	66	55.8	103	103½	2.958
'78-87	79	95	76	84	73	71	81	76	79	82.1	97	99½	3.264
1818-27	109	90	151	111	128	105	106	112	111	98.0	—	—	3.692

* Silver (see note on p. 386), parity of 1 gold to 15½ silver = 100.

† Wheat harvest in U.K. to 1895: 29 bushels = 100; from 1896: 30 bushels = 100.

‡ Average price of Consols and the average Bank of England rate of discount are actual figures, not index-numbers; Consols 3% to 1888, 2½% from 1889, 2½% from April, 1903.

Wholesale Prices in 1950

411

1951]

THE STATIST'S Index Numbers—monthly average by groups, 1867-77 = 100

	Vegetable Food	Animal Food	Sugar, Tea, and Coffee	Food-stuffs	Minerals	Textiles	Sundry Materials	Total Materials	All Com. commodities
1948									
Jan.	207.5	146.1	100.0	162.3	350.8	334.5	278.2	315.0	250.5
Feb.	207.7	155.3	101.5	166.0	356.4	335.3	279.4	317.3	253.4
Mar.	210.4	155.3	108.5	168.7	359.5	338.7	280.7	319.8	256.0
April	210.0	155.3	105.7	168.0	360.2	342.6	280.6	321.1	256.4
May	211.4	155.3	103.4	168.0	359.4	364.4	279.6	327.2	260.0
June	225.1	155.3	105.8	174.3	367.8	363.4	280.2	329.4	263.9
July	214.6	155.3	106.9	170.1	367.6	355.1	279.1	326.4	260.4
Aug.	217.2	155.3	107.8	171.4	366.9	350.6	279.7	325.0	260.1
Sept.	217.1	155.3	105.5	170.9	367.3	345.0	275.9	321.8	258.1
Oct.	217.7	155.3	110.6	172.2	385.1	342.9	278.1	326.8	261.5
Nov.	222.5	155.3	112.2	174.5	384.9	348.4	279.3	329.0	263.8
Dec.	221.8	155.3	114.7	174.8	384.7	357.0	281.8	332.6	266.0
1949									
Jan.	223.6	155.3	117.2	176.1	392.4	358.1	280.4	334.4	267.6
Feb.	224.7	155.3	119.0	177.0	392.3	353.8	278.7	332.4	266.8
Mar.	226.3	155.3	114.7	176.7	391.4	347.1	278.9	330.2	265.4
April	242.7	195.4	115.0	198.4	380.0	344.1	278.1	325.9	272.0
May	243.7	197.4	117.1	200.0	370.9	338.3	273.6	319.7	269.2
June	251.0	197.4	121.0	203.9	359.0	333.1	270.3	313.5	267.2
July	246.5	197.4	123.1	202.4	358.7	319.1	267.3	307.8	263.3
Aug.	238.7	197.4	123.8	199.3	360.7	321.1	266.6	308.7	262.5
Sept.	248.9	197.4	152.8	209.7	414.7	372.3	271.9	341.2	285.7
Oct.	248.9	197.4	173.5	214.0	403.2	397.3	277.6	348.2	291.5
Nov.	251.7	197.4	205.0	221.9	382.9	407.9	278.7	346.5	293.7
Dec.	251.9	197.4	216.5	224.3	383.4	416.7	282.3	350.9	297.4
1950									
Jan.	253.1	197.4	222.4	226.1	382.8	425.5	284.4	354.3	300.2
Feb.	252.8	197.4	214.9	224.4	382.1	426.1	290.8	357.0	301.0
Mar.	253.4	197.4	204.5	222.5	371.2	437.3	295.5	359.5	301.7
April	266.9	200.6	202.3	228.9	375.0	437.8	296.2	361.0	305.2
May	269.7	204.2	199.3	230.8	382.5	443.5	296.6	364.9	308.3
June	280.5	204.2	213.6	238.3	379.7	445.0	292.4	362.8	310.3
July	267.9	204.2	224.1	235.2	401.1	470.3	296.2	377.9	317.7
Aug.	266.2	204.2	245.0	238.9	419.2	528.9	295.0	400.4	332.1
Sept.	268.3	209.1	236.2	239.7	436.6	527.3	298.0	405.8	335.7
Oct.	283.7	209.1	236.2	246.2	464.1	554.6	305.0	424.6	349.2
Nov.	286.9	209.1	229.4	246.2	492.5	595.5	313.9	448.6	363.1
Dec.	292.5	210.1	236.9	250.4	490.8	620.8	326.7	461.4	372.3
1951									
Jan.	292.5	210.1	243.0	251.7	520.2	730.3	359.1	516.7	404.8
Feb.	295.0	210.1	248.4	253.9	538.6	769.3	379.4	542.2	420.5
Mar.	297.4	210.1	240.3	253.2	523.6	750.0	399.2	540.6	419.3
April	315.5	210.1	241.3	261.0	523.9	771.3	396.5	546.1	425.7
May	314.0	216.2	255.5	265.7	523.1	721.8	403.9	533.8	420.6

Quarterly Movements of Prices *

Summary of Index Numbers, 1867-77 = 100

Years	Quar- ters	Vege- table Food (Corn, etc.)	Animal Food (Meat, etc.)	Sugar, Coffee, and Tea	Total Food	Minerals	Textiles	Sundry Materials	Total Materials	Grand Total	Silver †
'39	I	68.0	110.9	43.5	78.7	134.2	79.6	84.0	96.2	88.8	17.7
	II	66.7	112.9	46.9	79.6	134.4	85.7	85.3	98.7	90.6	17.3
	III	65.2	117.0	48.1	80.7	135.8	91.1	88.0	101.8	92.9	15.7
	IV	93.2	130.3	57.4	99.3	146.7	123.5	106.4	122.5	112.7	17.8
'40	I	104.2	141.2	57.4	108.0	160.1	141.2	116.1	135.6	124.0	16.3
	II	108.0	140.5	56.7	109.2	165.2	148.4	122.2	141.8	128.0	16.7
	III	117.3	140.5	58.6	113.5	171.1	148.6	122.2	143.4	130.9	17.6
	IV	127.5	140.5	58.8	117.8	173.5	151.9	119.8	144.1	133.0	17.9
'41	I	129.8	141.3	61.9	119.8	179.0	154.8	124.7	148.6	136.4	18.0
	II	137.9	142.8	65.3	124.4	181.2	161.6	137.2	156.6	143.0	18.0
	III	145.0	142.8	65.4	127.4	181.0	165.6	138.5	158.3	145.3	18.0
	IV	151.0	142.8	68.9	130.7	181.6	163.1	134.2	155.8	145.2	18.1
'42	I	179.6	144.3	69.3	143.4	181.6	161.1	140.6	157.9	151.8	18.1
	II	188.6	147.3	69.5	148.3	182.2	160.4	146.1	160.2	155.2	18.1
	III	158.4	147.3	71.4	136.0	185.8	158.3	144.1	159.7	149.7	18.1
	IV	156.6	151.1	71.4	136.7	186.8	164.9	145.0	162.0	151.3	18.1
'43	I	159.1	155.7	72.8	139.7	188.0	163.9	148.4	163.8	153.5	18.1
	II	159.9	155.7	73.1	140.1	188.3	165.1	153.5	166.4	155.3	18.1
	III	156.1	155.7	74.1	138.7	188.2	163.4	156.0	166.9	155.0	18.1
	IV	150.1	155.7	74.2	136.2	187.8	160.8	157.4	166.6	153.8	18.1
'44	I	151.6	155.7	73.7	136.7	191.4	161.1	159.6	168.6	155.2	18.1
	II	151.8	155.7	74.5	137.0	193.9	180.0	160.2	175.3	159.1	18.1
	III	152.2	155.7	75.8	137.4	199.3	183.7	161.4	178.5	161.2	18.1
	IV	151.4	155.7	73.7	136.7	203.9	184.6	155.4	177.5	160.2	18.1
'45	I	154.8	155.7	73.7	138.0	204.8	186.0	157.3	178.9	161.7	19.6
	II	160.5	155.7	74.6	140.6	209.4	189.8	158.3	181.7	164.4	19.5
	III	157.7	155.7	73.8	139.2	212.5	189.7	156.2	181.6	163.7	20.2
	IV	154.7	155.7	74.4	138.2	212.1	190.0	154.3	180.8	162.9	31.1
'46	I	155.7	155.7	78.6	139.4	225.5	191.5	155.9	185.5	166.1	31.1
	II	157.2	154.3	81.0	140.1	230.9	195.1	160.9	190.3	169.1	31.1
	III	156.0	154.3	84.5	140.3	248.5	211.6	168.9	203.4	176.9	38.2
	IV	153.0	154.7	86.6	139.7	260.9	272.3	205.9	240.9	198.3	41.6
'47	I	156.0	154.7	91.4	141.9	282.9	286.7	223.4	258.9	209.5	36.7
	II	162.9	150.3	98.0	144.7	288.9	284.5	246.5	269.6	216.8	32.8
	III	187.1	146.7	102.2	154.3	295.4	298.0	253.6	278.5	222.5	30.4
	IV	200.8	144.0	103.0	159.3	322.7	330.0	267.8	300.9	241.1	33.4
'48	I	208.5	152.2	103.3	165.7	355.6	336.2	279.4	317.4	253.3	33.7
	II	215.5	155.3	105.0	170.1	362.5	356.8	280.1	325.9	260.1	33.7
	III	216.3	155.3	106.7	170.8	367.3	350.2	278.2	324.4	259.5	33.9
	IV	220.7	155.3	112.5	173.8	384.9	349.4	279.7	329.5	263.8	33.6
'49	I	224.9	155.3	117.0	176.6	392.0	353.0	279.3	332.3	266.6	32.2
	II	245.8	196.7	117.7	200.8	370.0	338.5	274.0	319.7	269.4	32.6
	III	244.7	197.4	133.2	203.8	378.0	337.5	268.6	319.2	270.5	33.0
	IV	250.8	197.4	198.3	220.1	389.8	407.3	279.5	348.5	290.9	33.3
'50	I	253.1	197.4	213.9	224.3	378.7	429.6	290.2	356.9	300.6	33.3
	II	272.4	203.0	205.1	232.7	379.1	442.1	295.1	362.9	307.9	33.0
	III	267.5	205.8	235.1	237.9	419.0	508.8	296.4	394.7	328.5	33.1
	IV	287.7	209.4	234.2	247.6	482.5	590.3	315.2	444.9	361.5	35.6

* The averages of the four quarterly figures to each year do not necessarily coincide with the annual averages, as the latter are based as far as possible on average weekly prices. See also the *Journal*, 1893, p. 221; 1895, p. 144; 1901, p. 90; and 1909, p. 70.

† Silver, parity of 1 gold to 15½ silver = 100.

1951]

Construction of the Tabular Statements

The following table illustrates the method of construction of the index numbers. The index numbers here given are based on the average prices for the eleven years 1867-77. Take, for instance, the *Gazette* price of English wheat:

	s.	d.	
Average, 1867-77	54	6	= 100, average point.
" 1914	35	0	= 64, or 36 per cent. below the average point.
" 1930	80	7	= 148, " 48 " above " "
" 1936	53	3	= 98, " 2 " below " "

The individual index numbers, therefore, represent simple percentages of the average point. The articles are grouped in six categories:

	Index Nos.	1867-77 Total Numbers	Example for 1950	
			Total Numbers	Average
1. Vegetable food, corn, etc. (wheat flour, barley, oats, maize, potatoes, and rice)	8	800	2,141	268
2. Animal food (beef, mutton, pork, bacon, and butter)	7	700	1,427	204
3. Sugar, coffee, and tea	4	400	896	224
1-3. Food	19	1,900	4,464	235
4. Minerals (iron, copper, tin, lead, and coal)	7	700	2,913	416
5. Textiles (cotton, flax, hemp, jute, wool, and silk)	8	800	3,927	491
6. Sundry materials (hides, leather, tallow, oils, soda, nitrate, indigo, and timber)	11	1,100	3,294	299
4-6. Materials	26	2,600	10,134	390
General Average	45	4,500	14,598	324

The general average is drawn from all forty-five descriptions which are treated as of equal value, and is the simple arithmetic mean as shown above.

Index of Silver Prices

The base of the index numbers given below is 60·84*d.* per standard oz. \approx 100, this being a parity of 1 fine oz. of gold to 15½ standard ozs. of silver.*

	Price per oz. standard	Index number		Price per oz. standard	Index number
	<i>d.</i>			<i>d.</i>	
Average 1873	59½	=97·4	Lowest Nov., 1902 ..	21½	=35·6
" '90-99	34	=55·8	End Dec., 1906	32½	=53·1
" 1917-26	40½	=66·6	" Dec., '08	23½	=38·1
" 1893	35½	=58·6	" Dec., '13	26½	=43·7
" 1914	25½	=41·6	" Dec., '14	22½	=37·3
" '15	23½	=38·9	" Dec., '15	26½	=43·1
" '16	31½	=50·4	" Dec., '16	36½	=58·7
" '17	40½	=65·8	" Dec., '17	43½	=70·0
" '18	47½	=76·4	" Dec., '18	48½	=77·9
" '19	57	=85·3	" Dec., '19	77½	=98·3
" '20	61½	=76·1	" Dec., '20	40½	=49·2
" '21	36½	=48·1	" Dec., '21	34½	=49·3
" '22	34½	=51·6	" Dec., '22	31½	=49·6
" '23	31½	=49·4	" Dec., '23	33½	=49·0
" '24	34	=50·7	" Dec., '24	31½	=50·4
" '25	32½	=52·5	" Dec., '25	31½	=52·1
" '26	28½	=47·1	" Dec., '26	25	=41·1
" '27	26½	=42·8	" Dec., '27	26½	=43·6
" '28	26½	=44·0	" Dec., '28	26½	=43·3
" '29	24½	=40·2	" Dec., '29	21½	=35·2
" '30	17½	=29·0	" Dec., '30	14½	=23·7
" '31	14½	=20·4	" Dec., '31	20½	=21·6
" '32	17½	=19·5	" Dec., '32	16½	=17·2
" '33	18½	=18·7	" Dec., '33	19½	=19·5
" '34	21½	=20·0	" Dec., '34	24½	=22·6
" '35	29	=26·4	" Dec., '35	22½	=20·6
" '36	20½	=18·5	" Dec., '36	21½	=19·4
" '37	20½	=18·4	" Dec., '37	19½	=17·7
" '38	19½	=17·6	" Dec., '38	20½	=17·3
" '39	20½	=17·1	" Dec., '39	22½	=17·3
" '40	22½	=17·1	" Dec., '40	23½	=17·9
" '41	23½	=18·0	" Dec., '41	23½	=18·1
" '42	23½	=18·1	" Dec., '42	23½	=18·1
" '43	23½	=18·1	" Dec., '43	23½	=18·1
" '44	23½	=18·1	" Dec., '44	23½	=18·1
" '45	30½	=23·1	" Dec., '45	44	=31·1
" '46	48½	=36·7	" Dec., '46	55½	=41·6
" '47	44½	=33·3	" Dec., '47	45	=33·8
" '48	45	=34·1	" Dec., '48	2½	=31·9
" '49	49½	=32·8	" Dec., '49	64	=33·3
" '50	64½	=33·7	" Dec., '50	70	=36·4

* All the index numbers in the table from 1916 to 1925 inclusive and from 1931 to date are calculated on the basis of the gold prices of silver instead of the sterling prices, though the latter are the price quotations given in the table. In arriving at the index numbers for these dates the prices of gold are taken as follows: For 1916, 1917 and 1918 the price is taken as 86*s.* 9½*d.* per fine oz., derived from the "pegged" New York rate of \$4·76½ to the £. For 1919 the average price of gold is taken as 93*s.* 4½*d.*, this being the parity price with the U.S. dollar, the average New York exchange in that year being \$4·429. For the other dates the index numbers are based on the quotations in the London market for exportable gold.

1951]

World's Production of Silver (in millions of ounces)

	United States	Mexico	Canada	Australia	Other Countries	Total
1906	56.5	55.2	8.5	14.2	30.6	165.0
'07	56.5	61.0	12.8	19.0	34.8	184.2
'08	52.4	73.6	22.1	17.2	37.8	203.1
'09	54.7	73.9	27.5	16.3	39.7	212.1
'10	57.1	71.4	32.9	21.5	38.8	221.7
'11	60.4	79.0	32.7	16.6	37.5	226.2
'12	63.8	74.6	31.6	18.1	36.2	224.3
'13	66.8	70.7	31.5	3.5	51.4	223.9
'14	72.4	27.5	28.4	3.6	36.5	168.4
'15	74.9	39.5	28.4	4.1	37.3	184.2
'16	74.4	38.2	25.4	4.2	26.6	168.8
'17	71.7	35.0	22.2	10.0	35.3	174.2
'18	67.8	62.5	21.2	10.0	35.9	197.4
'19	56.7	62.7	15.7	7.4	32.0	174.5
'20	55.5	66.8	12.6	7.5	33.0	175.4
'21	53.1	64.5	13.1	4.9	35.7	171.3
'22	56.2	81.1	18.6	11.3	46.3	213.5
'23	73.3	90.9	17.8	13.3	50.7	246.0
'24	65.3	91.5	19.7	10.8	52.2	239.5
'25	66.1	92.9	20.2	11.1	54.8	245.1
'26	62.7	98.3	22.4	11.2	59.0	253.6
'27	60.4	104.6	22.7	9.0	57.3	254.0
'28	58.4	108.5	21.9	9.0	59.5	257.3
'29	61.2	108.7	23.1	9.0	59.7	261.7
'30	51.0	105.0	26.0	8.9	57.1	248.0
'31	31.0	86.0	21.0	7.6	50.4	196.0
'32	24.0	69.0	18.0	6.5	47.5	165.0
'33	22.8	68.1	15.2	11.0	52.0	169.1
'34	32.5	74.1	16.4	10.8	56.6	190.4
'35	45.6	75.6	16.6	11.4	71.5	220.7
'36	63.4	77.5	18.3	12.7	81.8	253.7
'37	71.3	84.7	22.7	14.3	81.5	274.5
'38	61.7	81.0	23.8	101.3	—	267.8
'39	63.9	75.9	24.5	101.6	—	265.9
'40	68.3	82.6	25.3	96.3	—	272.5
'41	71.1	78.4	23.4	81.7	—	254.6
'42	54.5	84.9	21.8	71.8†	—	—
'43	44.8	71.2	18.6	59.3†	—	—
'44	37.4	63.0	14.8	57.7†	—	—
'45	29.3	61.1	14.0	46.4†	—	—
'46	21.4	48.3	13.6	47.1†	—	—
'47	36.1	49.2	13.5	44.6†	—	—
'48	36.1	45.8	17.0	46.0†	—	—
'49	34.6	49.5	18.2	44.3†	—	—
'50*	42.0	47.0	21.5	44.2†	—	—

* Provisional. (Estimate by Messrs. Samuel Montagu & Co.) † Incomplete

(000's omitted)

Year	Value of output £	Year	Value of output £	Year	Value of output £
1851	17,200	1885	21,250	1919	73,078
'52	26,550	'86	21,430	'20	68,522
'53	31,090	'87	21,735	'21	67,848
'54	25,490	'88	22,644	'22	66,723
'55	27,015	'89	25,375	'23	77,888
'56	29,520	'90	24,421	'24	81,807
'57	26,655	'91	26,846	'25	82,267
'58	24,930	'92	30,134	'26	82,211
'59	24,970	'93	32,363	'27	82,582
'60	23,850	'94	37,229	'28	82,400
'61	22,760	'95	40,843	'29	84,500
'62	21,550	'96	41,559	'30	88,500
'63	21,390	'97	48,509	'31	95,100
'64	22,600	'98	58,949	'32	103,400
'65	24,040	'99	63,027	'33	107,700
'66	24,220	1900	52,312	'34	116,000
'67	22,805	'01	53,630	'35	125,700
'68	21,945	'02	60,975	'36	140,900
'69	21,245	'03	67,337	'37	148,700
'70	21,370	'04	71,380	'38	159,000
'71	25,400	'05	78,143	'39	165,900
'72	24,200	'06	82,707	'40	174,000
'73	23,600	'07	84,857	'41	167,200
'74	22,950	'08	90,995	'42	146,300
'75	22,700	'09	93,302	'43	113,200
'76	22,540	'10	93,544	'44	103,300
'77	23,830	'11	94,930	'45	98,200
'78	22,020	'12	95,783	'46	99,900
'79	21,400	'13	97,481	'47	101,400
'80	22,130	'14	92,709	'48	104,700*
'81	21,150	'15	97,114	'49	108,400*
'82	20,500	'16	92,597	'50	110,500*
'83	20,640	'17	87,236		
'84	20,830	'18	78,605		

Gold.—The table shows the world's annual gold production since 1851. Before 1911 the estimates are those of the Bureau of the U.S. Mint and other authorities. The estimates since 1926 are those of the Union Corporation, Limited. The value is taken throughout at £4.25 per fine oz.

* Estimated or provisional figure.

Digitized by Arya Samaj Foundation Chennai and eGangotri

Average Prices of Commodities

No. of Article	0.	1	2	3	4	5	6	7	8	1-8	9	10
Year	Silver †	Wheat		Flour	Barley	Oats	Maize ‡	Potatoes*	Rice	Vegetable Food	Beef ‡	
		English Gazette	American	Town Made white (now "G.R.")	English Gazette	English Gazette	American Mixed	Good English	Rangoon Cargoes to Arrive	Total	Prime	Midling
	d. per oz.	s. and d. per qr.	s. and d. per qr.	s. per sack (280 lbs.)	s. and d. per qr.	s. and d. per qr.	s. per qr.	s. per ton	s. and d. per cwt.		d. per 8 lbs.	d. per 8 lbs.
1922 ..	34 ⁷ / ₁₆	47.10	52.11	45 ¹ / ₂	40.1	29.1	31 ¹ / ₂	130	14.10	—	88 ⁵ / ₈	82
'29 ..	24 ⁷ / ₁₆	42.2	51.3	38 ¹ / ₂	35.5	24.7	36 ¹ / ₂	111	14.3	—	71	66
'30 ..	17 ¹ / ₁₆	34.3	36.10	33 ¹ / ₂	28.3	17.2	23	93	13.0	—	73	68
'31 ..	14 ¹ / ₁₆	24.0	25.1	22 ¹ / ₂	28.0	17.8	15 ¹ / ₂	146	9.8	—	67	61
'32 ..	17 ¹ / ₁₆	25.0	27.5	24 ¹ / ₂	27.1	19.3	18 ¹ / ₂	152	9.8	—	65	59
'33 ..	18 ¹ / ₁₆	22.10	25.7	23 ¹ / ₂	28.7	15.10	17 ¹ / ₂	86	7.9	—	61	52
'34 ..	21 ¹ / ₁₆	20.2	28.0	23 ¹ / ₂	30.11	17.5	19 ¹ / ₂	97	7.8	—	58	52
'35 ..	29	22.2	31.1	25 ¹ / ₂	28.7	18.9	17 ¹ / ₂	107	8.10	—	54	49
'36 ..	20 ¹ / ₁₆	30.9	35.1	31 ¹ / ₂	29.5	17.8	19 ¹ / ₂	146	9.0	—	54	50
'37 ..	20 ¹ / ₁₆	40.0	49.7	40 ¹ / ₂	39.0	23.11	26 ¹ / ₂	136	10.5	—	61	57
'38 ..	19 ¹ / ₁₆	28.11	39.3	30 ¹ / ₂	36.4	21.2	28 ¹ / ₂	111	10.7	—	62	58
'39 ..	20 ¹ / ₁₆	21.5	30.1	22 ¹ / ₂	31.7	19.3	26 ¹ / ₂	117	11.1	—	61	58
'40 ..	22 ¹ / ₁₆	42.10	33.6	24 ¹ / ₂	64.10	37.2	39 ¹ / ₂	143	15.5	—	72	68
'41 ..	23 ¹ / ₁₆	62.10	32.2	27 ¹ / ₂	85.8	40.10	43	164	23.8	—	72	68
'42 ..	23 ¹ / ₁₆	68.6	36.9	35	165.5	42.0	43	134	26.0	—	76	68
'43 ..	23 ¹ / ₁₆	69.8	45.5	38 ¹ / ₂	112.5	43.8	43	111	27.2	—	79	71
'44 ..	23 ¹ / ₁₆	63.11	56.0	38 ¹ / ₂	94.6	45.3	43	115	27.2	—	79	71
'45 ..	30 ¹ / ₁₆	61.10	63.7	40	89.2	45.9	43	139	27.2	—	79	71
'46 ..	48 ¹ / ₁₆	63.7	65.11	40	86.6	45.3	43	137	27.2	—	79 ¹ / ₂	72
'47 ..	44 ¹ / ₁₆	71.9	68.10	40	88.7	50.9	43	162	49.6	—	80	72
'48 ..	45	90.0	73.4	40	95.8	58.0	43	207	57.6	—	79	72
'49 ..	49 ¹ / ₁₆	99.6	88.3	43 ¹ / ₂	92.4	58.6	72 ¹ / ₂	222	61.0	—	103 ¹ / ₂	88 ¹ / ₂
'50 ..	64 ¹ / ₁₆	110.8	107.9	52	99.8	60.2	105 ¹ / ₂	225	63.0	—	114	96
Average 1904-13	26 ¹ / ₁₆	31 ¹ / ₂	36	30	25 ¹ / ₂	18 ¹ / ₂	24 ¹ / ₂	78	7 ¹ / ₂	—	51	44 ¹ / ₂
1890-99	34	28 ¹ / ₂	31 ¹ / ₂	27 ¹ / ₂	25 ¹ / ₂	17 ¹ / ₂	19 ¹ / ₂	72	6 ¹ / ₂	—	47	37 ¹ / ₂
'78-87	50	40	43 ¹ / ₂	34 ¹ / ₂	31 ¹ / ₂	21	25	102	8	—	55 ¹ / ₂	46
'67-77	58 ¹ / ₂	54 ¹ / ₂	56	46	39	26	32 ¹ / ₂	117	10	—	59	50

Index Numbers (or Percentages) of Prices, the Average of 1867-77 being 100

Year	0.	1	2	3	4	5	6	7	8	1-8	9	10
1922 ..	51.6	88	95	100	103	112	96	111	148	853	150	164
'29 ..	40.2	77	91	84	91	95	112	95	143	788	120	132
'30 ..	29.0	63	66	72	72	66	71	79	130	619	124	136
'31 ..	20.4	44	45	50	71	68	48	125	93	544	114	122
'32 ..	19.5	46	49	53	69	74	58	130	93	572	110	118
'33 ..	18.7	42	46	52	73	61	53	74	78	479	103	104
'34 ..	20.0	37	50	50	79	67	60	83	77	503	98	104
'35 ..	26.4	41	56	56	73	72	53	91	88	530	92	98
'36 ..	18.5	56	63	69	75	68	60	125	90	606	92	100
'37 ..	18.4	73	89	88	100	92	82	116	105	745	103	114
'38 ..	17.6	53	70	67	93	81	86	95	106	651	105	116
'39 ..	17.1	39	54	48	81	74	82	100	111	589	103	116
'40 ..	17.1	78	60	53	166	143	122	122	154	898	122	136
'41 ..	18.0	115	57	60	220	157	132	140	236	1,117	122	136
'42 ..	18.1	126	66	76	424	162	132	115	260	1,361	129	136
'43 ..	18.1	128	81	83	288	168	132	95	272	1,247	134	142
'44 ..	18.1	117	100	84	242	174	132	98	272	1,219	134	142
'45 ..	23.1	113	114	87	229	176	132	118	272	1,241	134	142
'46 ..	36.7	117	118	87	222	174	132	117	272	1,239	135	144
'47 ..	33.3	132	123	87	227	195	132	138	495	1,529	135	144
'48 ..	34.1	165	131	87	245	223	132	177	576	1,736	134	144
'49 ..	32.8	183	158	95	237	225	223	190	610	1,921	175	177
'50 ..	33.7	203	192	113	255	231	325	192	630	2,141	193	192

* The annual prices are the average monthly or weekly quotations, except potatoes, which are the average weekly quotations during the eight months January to April and September to December.

† Not included in the general average. ‡ Meat (9-13), by the carcase, in the London Central Meat Market.

§ La Plata from 1924-40. || Argentine maize (Feeding Stuffs); £10 per ton fixed by Ministry of Food.

Digitized by Arya Bama Foundation, Orensi and Gangaotri

No. of Article	11	12	13	14	15	9-15	16A	16B	17	18A *	18B *	18
	Mutton		Pork	Bacon	Butter		Sugar			Coffee		
Year	Prime	Midd-ling	Large and Small, average	Water-ford	Friesland, Fine to Finest	Animal Food Total	British West Indian Refining	Beet, German, 88 p. c., f.o.b.	Java, Floating, Cargoes	Ceylon Plantation, Low Middling	Rio, Good	Mean of 18A and 18B
	d. per 8 lbs.	d. per 8 lbs.	d. per 8 lbs.	s. per cwt.	s. per cwt.		s. per cwt.	s. per cwt.	s. per cwt.	s. per cwt.	s. per cwt.	
1922 ..	125	121 $\frac{3}{8}$	101	145 $\frac{1}{2}$	202 $\frac{1}{2}$	—	15	14 $\frac{1}{8}$	15 $\frac{5}{16}$	120 $\frac{3}{8}$	74 $\frac{1}{2}$	—
'29 ..	89 $\frac{1}{2}$	83	91	116 $\frac{1}{2}$	180 $\frac{1}{8}$	—	11 $\frac{7}{8}$	8 $\frac{5}{16}$	8 $\frac{7}{8}$	141 $\frac{1}{8}$	74 $\frac{3}{8}$	—
'30 ..	92	86	89	105 $\frac{3}{8}$	146 $\frac{1}{8}$	—	8 $\frac{3}{8}$	5 $\frac{3}{8}$	6 $\frac{1}{2}$	106 $\frac{3}{8}$	42 $\frac{3}{8}$	—
'31 ..	79	73	65	83 $\frac{3}{8}$	130	—	7 $\frac{1}{8}$	5 $\frac{1}{16}$	6 $\frac{7}{16}$	101 $\frac{1}{4}$	33 $\frac{1}{8}$	—
'32 ..	63	55	54	77	126 $\frac{3}{8}$	—	7 $\frac{1}{2}$	5 $\frac{1}{16}$	5 $\frac{1}{8}$	105 $\frac{3}{8}$	54 $\frac{5}{16}$	—
'33 ..	69	63	60	81 $\frac{1}{2}$	105 $\frac{9}{16}$	—	7 $\frac{1}{2}$	4 $\frac{3}{8}$	5 $\frac{1}{8}$	86 $\frac{3}{8}$	42 $\frac{1}{8}$	—
'34 ..	74	70	65	90 $\frac{3}{8}$	79 $\frac{5}{16}$	—	6 $\frac{3}{8}$	4 $\frac{5}{16}$	4 $\frac{1}{16}$	87 $\frac{7}{8}$	42 $\frac{1}{8}$	—
'35 ..	75	70	62	89	92 $\frac{3}{8}$	—	6 $\frac{1}{16}$	3 $\frac{1}{8}$	4 $\frac{1}{8}$	67 $\frac{9}{16}$	29 $\frac{3}{8}$	—
'36 ..	73	68	65	93 $\frac{7}{8}$	98 $\frac{1}{8}$	—	6 $\frac{1}{8}$	3 $\frac{1}{8}$	4 $\frac{1}{8}$	58 $\frac{1}{2}$	30 $\frac{3}{8}$	—
'37 ..	78	74	68	94	108 $\frac{3}{8}$	—	7 $\frac{1}{8}$	5 $\frac{1}{8}$	6 $\frac{1}{8}$	75 $\frac{1}{4}$	36 $\frac{1}{2}$	—
'38 ..	62	56	69	97 $\frac{1}{16}$	114 $\frac{9}{16}$	—	7 $\frac{1}{8}$	4 $\frac{5}{16}$	5 $\frac{1}{8}$	75	19 $\frac{1}{2}$	—
'39 ..	68	64	70	97 $\frac{1}{8}$	122	—	9 $\frac{1}{8}$	6 $\frac{1}{8}$	7 $\frac{7}{8}$	73 $\frac{3}{8}$	22 $\frac{1}{2}$	—
'40 ..	85	76	96	114 $\frac{7}{8}$	143	—	9 $\frac{3}{8}$	—	8 $\frac{3}{8}$	86 $\frac{5}{16}$	28 $\frac{1}{8}$	—
'41 ..	85	76	96	123 $\frac{1}{16}$	142 $\frac{1}{16}$	—	9 $\frac{3}{8}$	—	8 $\frac{3}{8}$	137 $\frac{1}{2}$	30 $\frac{1}{2}$	—
'42 ..	90	78	101	130	143 $\frac{1}{2}$	—	9 $\frac{3}{8}$	—	8 $\frac{3}{8}$	130 $\frac{1}{2}$	28 $\frac{3}{4}$	—
'43 ..	96	84	102	142	151 $\frac{1}{4}$	—	9 $\frac{3}{8}$	—	8 $\frac{3}{8}$	140 $\frac{1}{2}$	37 $\frac{1}{2}$	—
'44 ..	96	84	102	142	151 $\frac{1}{4}$	—	9 $\frac{3}{8}$	—	8 $\frac{3}{8}$	140 $\frac{1}{2}$	37 $\frac{1}{2}$	—
'45 ..	96	84	102	142	151 $\frac{1}{4}$	—	9 $\frac{3}{8}$	—	8 $\frac{3}{8}$	140 $\frac{1}{2}$	59 $\frac{1}{2}$	—
'46 ..	100 $\frac{3}{4}$	81 $\frac{1}{2}$	97	142	139 $\frac{3}{4}$	—	—	—	23 $\frac{1}{2}$	150 $\frac{1}{2}$	77 $\frac{1}{2}$	—
'47 ..	101	81	98	124 $\frac{1}{2}$	126	—	—	—	27 $\frac{1}{2}$	150 $\frac{1}{2}$	73 $\frac{3}{8}$	—
'48 ..	100	81	99	154 $\frac{3}{4}$	122 $\frac{1}{2}$	—	—	—	24 $\frac{1}{8}$	169	79	—
'49 ..	127 $\frac{3}{4}$	92 $\frac{1}{8}$	127 $\frac{3}{8}$	159 $\frac{1}{2}$	134 $\frac{1}{8}$	—	—	—	26 $\frac{1}{4}$	356	145	—
'50 ..	140	98	140	175 $\frac{3}{4}$	168 $\frac{1}{4}$	—	—	—	40 $\frac{3}{8}$	532	297 $\frac{1}{4}$	—
Average												
1904-13	58 $\frac{1}{2}$	51 $\frac{3}{4}$	47 $\frac{5}{8}$	67	113	—	10 $\frac{1}{8}$	10 $\frac{7}{8}$	12	75 $\frac{1}{2}$	43 $\frac{3}{4}$	—
1890-99	54 $\frac{1}{2}$	41 $\frac{1}{2}$	42 $\frac{3}{4}$	59	100	—	11 $\frac{1}{2}$	11 $\frac{1}{2}$	13 $\frac{1}{2}$	98	62	—
'78-87	64 $\frac{1}{2}$	53	49	71	116	—	17	18	21 $\frac{1}{2}$	78	52	—
'67-77	63	55	52	74	125	—	23	24	28 $\frac{1}{2}$	87	64	—

Index Numbers (or Percentages) of Prices, the Average of 1867-77 being 100

Year	11	12	13	14	15	9-15	16A	16B	17	18A *	18B *	18
1922 ..	199	221	194	196	162	1,286	62	—	54	140	116	128
'29 ..	142	151	175	157	144	1,021	42	—	31	162	117	140
'30 ..	146	155	171	143	117	992	31	—	22	123	66	95
'31 ..	125	133	125	113	104	836	29	—	23	120	53	87
'32 ..	100	100	104	104	101	737	27	—	20	121	85	103
'33 ..	110	114	115	110	84	740	25	—	18	100	66	83
'34 ..	117	127	125	122	64	757	22	—	16	100	67	84
'35 ..	119	127	119	120	74	749	21	—	17	78	46	62
'36 ..	116	124	131	127	79	763	21	—	17	67	48	58
'37 ..	124	135	125	127	86	820	28	—	23	87	57	72
'38 ..	98	102	133	131	92	777	24	—	19	86	31	59
'39 ..	108	116	135	132	98	808	32	—	26	85	35	60
'40 ..	135	138	185	155	114	985	42	—	29	99	44	72
'41 ..	135	138	185	167	114	997	42	—	29	158	47	102
'42 ..	143	142	194	176	115	1,035	42	—	29	150	45	98
'43 ..	152	153	196	192	121	1,090	42	—	29	161	58	109
'44 ..	152	153	196	192	121	1,090	42	—	29	161	58	109
'45 ..	152	153	196	192	121	1,090	42	—	29	161	93	127
'46 ..	160	148	187	192	112	1,078	—	—	82	172	121	146
'47 ..	160	147	188	168	101	1,043	—	—	96	172	115	143
'48 ..	159	147	190	209	99	1,082	—	—	85	194	123	158
'49 ..	203	169	245	216	107	1,292	—	—	92	409	227	318
'50 ..	222	178	269	238	135	1,427	—	—	142	611	464	537

* Index numbers not included in general average.

† Nominal.

† E. India good middling from 1908-1947. Kenya from 1948. § Raw Centrifugals, 96% Pol., from 1924.

‡ White Javas, C.I.F., from 1924.

Average Prices of Commodities—Contd.

No. of Article	Year	19A *	19B *	19	16-19	1-19	20A	20B	21	22	23	24	25
		Tea		Mean of 19A and 19B	Sugar, Coffee, and Tea Total	Food Total	Scottish Pig s. and d. per ton	Cleveland (Middlesbrough) Pig s. and d. per ton	Bars, Common per ton	Copper Standard £ per ton	Tin Straits £ per ton	Lead English Pig £ per ton	Coal Wallsend Hetton in London† s. per ton
		Congou, Com- mon d. per lb.	Average Import Price d. per lb.										
1922	..	8½	14.9	—	—	—	99.10	90.7	11½	63½	162	25½	34½
'29	..	6½	16.11	—	—	—	74.0	70.3	9½	75½	207½	24½	23½
'30	..	5½	15.12	—	—	—	76.0	67.0	9½	54½	144½	19½	24½
'31	..	4½	13.29	—	—	—	71.0	58.6	10½	38½	121½	14½	24½
'32	..	4½	10.75	—	—	—	68.2	58.6	10	31½	140	13½	23½
'33	..	6½	11.87	—	—	—	66	62.3	9½	32½	202½	13½	22½
'34	..	8½	13.20	—	—	—	69.6	66.11	9½	30½	232½	12½	20½
'35	..	6½	13.06	—	—	—	70.6	67.10	9½	32½	230½	16	20½
'36	..	6½	13.19	—	—	—	78.6	73.2	10½	37½	207½	19½	23½
'37	..	6½	14.58	—	—	—	104.6	94.4	12½	54½	246½	24½	24½
'38	..	6½	14.04	—	—	—	118.0	109	13½	41½	193½	17½	25½
'39	..	6½	14.18	—	—	—	104.3	100.7	12½	44½	232½	17½	25½
'40	..	—	15.33	—	—	—	114.10	116.4	14½	62	273½	26½	28½
'41	..	—	15.13	—	—	—	123	128	15½	62	284½	26½	30½
'42	..	—	16.25	—	—	—	123	128	15½	62	275	26½	32½
'43	..	—	18.44	—	—	—	123	128	15½	62	275	26½	34½
'44	..	—	19.48	—	—	—	123	128	16½	62	300	26½	38½
'45	..	—	20.06	—	—	—	139.11	140½	18	62	300	29½	42½
'46	..	—	21.31	—	—	—	167	165.5	19½	77½	321½	47½	45½
'47	..	—	27.65	—	—	—	176.9	175.4	20½	130½	426½	86½	48½
'48	..	—	32.21	—	—	—	194.5	193.5	21½	134	547½	97	54½
'49	..	—	33.72	—	—	—	228.11	204.7	20	132½	603½	104½	54½
'50	..	—	37.37	—	—	—	239.6	209.1	20	179	744½	111½	53
Average													
1904-13		7½	8½	—	—	—	57½	51½	6½	67½	164½	15½	18½
1890-99		4½	9½	—	—	—	47	41½	5½	50	81	12	17½
'78-87		6½	12½	—	—	—	46	38	5½	55	89	14	16½
'67-77		11½	17½	—	—	—	69	60	8½	75	105	20½	22

Index Numbers (or Percentages) of Prices, the Average of 1867-77 being 100

1828	1922	77	86	82	326	2,465	148	136	84	154	123	156
1895	'29	54	93	74	287	2,096	112	118	101	198	117	106
1887	'30	46	88	67	215	1,826	111	121	73	138	95	113
18103	'31	42	78	60	199	1,579	100	123	52	115	71	112
1883	'32	38	62	50	200	1,509	98	121	43	131	65	106
1884	'33	58	68	63	189	1,408	99	117	44	193	65	103
1862	'34	77	77	77	199	1,459	106	116	40	221	61	92
1858	'35	60	76	68	168	1,447	107	117	43	219	78	92
1872	'36	56	76	66	162	1,531	118	123	50	198	95	105
1859	'37	58	85	72	195	1,760	154	149	73	235	121	111
1860	'38	58	81	70	172	1,600	176	161	56	185	83	117
1872	'39	56	82	69	187	1,584	159	150	59	221	85	115
18102	'40	—	89	89	232	2,115	179	173	83	260	129	127
1898	'41	—	88	88	261	2,375	195	189	83	271	129	141
18109	'42	—	94	94	263	2,659	195	189	83	262	129	148
18109	'43	—	107	107	287	2,624	195	189	83	262	129	159
18127	'44	—	113	113	293	2,602	195	200	83	286	129	176
18146	'45	—	116	116	314	2,645	217	218	83	286	142	194
18143	'46	—	124	124	352	2,669	258	238	103	306	233	205
18158	'47	—	160	160	399	2,971	273	248	175	406	424	219
18318	'48	—	187	187	430	3,248	300	258	179	521	473	249
18537	'49	—	195	195	605	3,818	336	244	177	575	508	249
	'50	—	217	217	896	4,464	348	244	239	709	543	241

* Index numbers not included in the general average.

† Best Yorkshire house after 1916.

† First 9 months only.

Average Prices of Commodities—Contd.

No. of Article	26	20-26	27	28	29A	29B	30A	30B	31	32A	32B	33
	Coal	Mine-rals	Cotton		Flax		Hemp		Jute	Wool		
Year	Average Export Price s. per ton	Total	Middling American d. per lb.	Fair Dholerah II d. per lb.	Petro-grad † £ per ton	Russian Average Import Price £ per ton	Manila Fair Roping £ per ton	Petro-grad Clean (a) £ per ton	Good Medium ‡ £ per ton	Merino, Port Phillip, Average Fleeced d. per lb.	Merino, Adelaide, Average Greasy d. per lb.	English Lincoln Half Hogs d. per lb.
1922 ..	24.16	—	12.10	8	95	84 ⁷ / ₈	33 ¹ / ₂	57 *	30 ³ / ₄	39	17 ¹ / ₈	9 ¹ / ₂
'29 ..	16.13	—	10.26	7.73	76 ⁷ / ₈	71 ⁷ / ₈	37 ⁷ / ₈	61	32	35 ³ / ₈	13 ³ / ₈	16 ¹ / ₈
'30 ..	16.64	—	7.49	5.12	53 ¹ / ₈	60 ⁷ / ₈	26 ¹ / ₂	48 ⁷ / ₈	20	18 ⁹ / ₈	8 ³ / ₈	10 ¹ / ₈
'31 ..	15.98	—	5.90	4.60	36	35 ⁹ / ₈	18 ³ / ₈	27 ¹ / ₂	151 ⁵ / ₈	14.7	7.1	8 ¹ / ₈
'32 ..	16.27	—	5.24	4.85	45 ⁷ / ₈	42 ⁵ / ₈	18 ³ / ₈	36	16 ³ / ₈	15.0	7.2	5 ³ / ₈
'33 ..	16.08	—	5.54	4.53	51 ¹ / ₈	48 ¹ / ₈	15 ³ / ₈	37	14 ⁷ / ₈	19.9	9.3	5 ³ / ₈
'34 ..	16.08	—	6.70	4.80	60 ¹ / ₈	50 ³ / ₈	14 ³ / ₈	42 ⁵ / ₈	14 ³ / ₈	21 ¹ / ₄	10.4	7 ¹ / ₈
'35 ..	16.30	—	6.71	5.42	79 ¹ / ₈	72 ¹ / ₈	19 ³ / ₈	43 ¹ / ₄	161 ¹ / ₈	20.1	9.5	7 ¹ / ₈
'36 ..	16.98	—	6.71	5.12	63 ⁵ / ₈	60 ⁵ / ₈	28 ¹ / ₂	42 ⁷ / ₈	171 ¹ / ₈	24.7	12.2	10 ¹ / ₈
'37 ..	19.05	—	6.21	4.80	78 ¹ / ₈	70 ³ / ₈	34 ¹ / ₈	38 ³ / ₈	191 ¹ / ₈	26.9	12.7	16.9
'38 ..	21.32	—	4.93	3.67	66 ³ / ₈	63 ¹ / ₂	21 ³ / ₈	38 ¹ / ₈	17 ³ / ₈	18.6	8.9	11.9
'39 ..	21.12	—	5.95	4.41	90 ³ / ₈	72 ⁹ / ₈	22 ¹ / ₈	48 ¹ / ₈	261 ¹ / ₈	17.9	9.0	12.2
'40 ..	27.23	—	8.10	6.26	177 ¹ / ₂	183 ¹ / ₂	26 ¹ / ₂	100 ¹ / ₂	27 ¹ / ₂	29.6	14.9	19.4
'41 ..	32.22	—	9.14	7.65	200 †	—	31 ¹ / ₈	126 *	261 ³ / ₈	32	16 ¹ / ₈	21
'42 ..	34.87	—	8.83	7.37	200 †	201.6	33 †	130 *	24 ¹ / ₂	32	16 ¹ / ₈	21
'43 ..	36.91	—	7.83	6.38	200 †	205 †	33 †	130 *	33 ¹ / ₈	32	16 ¹ / ₈	21
'44 ..	39.19	—	11.32	9.50	200 †	205 †	40 ¹ / ₂ †	130 *	40 ¹ / ₂	32	16 ¹ / ₈	21
'45 ..	40.27	—	12.75	10.80	200 †	230 (b)	40 ¹ / ₂ †	130 *	39 ¹ / ₄	31.6	15.9	21.1
'46 ..	40.94	—	14.87	12.14	252	244 ³ / ₈ (b)	51	144 ¹ / ₂	49 ¹ / ₂	35 ³ / ₈	16 ¹ / ₈	20.7
'47 ..	47.61	—	21.21	16.28	262	248 (b)	92 ¹ / ₂	208 ¹ / ₈	80	58.2	30	22.7
'48 ..	74.07	—	23.23	17.80	274	281.3 (b)	88 ¹ / ₂	220 ⁷ / ₈	96 ⁹ / ₈	92 ¹ / ₈	61 ¹ / ₈	33
'49 ..	72.97	—	24.85	20.52	283 ¹ / ₂	244.3 (b)	105 ¹ / ₂	177 ⁷ / ₈	101 ¹ / ₂	92 ³ / ₈	65	38 ³ / ₈
'50 ..	73.65	—	36.15	32.96	351	296.7 (b)	144	195 ⁷ / ₈	112 ⁷ / ₈	157 ¹ / ₈	98 ¹ / ₈	65 ¹ / ₂
Average												
1904-13	11 ¹ / ₂	—	6 ¹ / ₂	5	32 ¹ / ₂	36 ¹ / ₈	30 ³ / ₈	31 ³ / ₈	18 ¹ / ₂	17 ³ / ₈	9	10 ¹ / ₈
1890-99	10 ³ / ₈	—	4 ¹ / ₂	3	27	27	26 ¹ / ₂	25	12 ¹ / ₂	13 ¹ / ₂	6 ¹ / ₂	10
'78-87	9	—	6	4 ¹ / ₂	33	34	35 ¹ / ₂	26 ¹ / ₂	15	18 ¹ / ₂	8 ³ / ₈	11 ¹ / ₂
'67-77	12 ¹ / ₂	—	9	6 ¹ / ₂	46	48	43	35	19	21 ¹ / ₂	9 ³ / ₈	19 ¹ / ₂

Index Numbers (or Percentages) of Prices, the Average of 1867-77 being 100

Year	193	994	134	118	191	116	162	180	49
1922 ..	193	994	134	118	191	116	162	180	49
'29 ..	129	881	114	114	157	126	168	156	81
'30 ..	133	784	83	76	121	96	105	86	54
'31 ..	127	700	66	68	76	58	84	70	43
'32 ..	130	694	58	72	93	70	85	71	29
'33 ..	129	750	62	67	106	68	78	94	30
'34 ..	129	765	74	71	119	73	74	102	35
'35 ..	130	786	74	80	161	80	89	96	37
'36 ..	136	825	74	76	133	91	93	119	53
'37 ..	152	995	69	71	158	93	104	127	86
'38 ..	171	949	55	54	139	77	93	88	60
'39 ..	169	958	66	65	174	91	140	86	62
'40 ..	218	1,169	90	93	383	163	146	142	98
'41 ..	258	1,266	101	113	416	202	139	155	106
'42 ..	279	1,285	98	109	427	209	130	155	106
'43 ..	295	1,312	87	95	431	209	174	155	106
'44 ..	314	1,383	126	141	431	219	212	155	107
'45 ..	322	1,462	142	160	457	219	207	153	105
'46 ..	328	1,671	165	180	528	251	259	167	114
'47 ..	381	2,126	236	241	543	385	421	283	167
'48 ..	594	2,574	258	264	598	396	510	492	194
'49 ..	584	2,673	276	304	562	363	534	506	333
'50 ..	589	2,913	402	488	689	435	593	821	

* Nominal.

† Livonian Z.K. from 1921-45. Medium grade continental w/retted from 1946.

‡ Lightnings from 1931 to 1942. Daisee ‡ from 1943.

(a) Russian Siretz Group 1, Sort 1 from 1931-33; Jugo-Slav Peasant from 1934-45. Italian S.B. from 1946.

(b) Belgian from 1945.

|| Now No. 1 Oomra, Fine.

1951]

Digitized by Arya Samaj Foundation, Chennai and eGangotri
Average Prices of Commodities—Contd.

33	No. of Article	34	27-34	35A	35B	35C	36A	36B	37	38	39	40A	40B
		Silk		Hides	Leather	Tallow	Oil	Seeds					
		Year		Textiles	River Plate, Dry	River Plate, Salted	Average Import Price	Dressing Hides	Average Import Price	Town	Palm	Olive	Linseed	Linseed
		Total	d. per lb.	d. per lb.	d. per lb.	d. per lb.	d. per lb.	s. per cwt.	£ per ton	£ per ton	£ per ton	s. per qr.	
		s. per lb.											
English Linen Half Hogs													
d. per lb.													
9 1/2	1922	28 3/4	—	9 1/8	8 7/8	8.06	24 1/2	36	34 1/8	34 3/8	75 1/2 †	39 1/8	75 1/2
16 1/4	'29	13 7/8	—	10 1/16	8 1/4	10.80	19 1/4	38 1/4	36 1/16	34 3/16	72	35 1/16	74 1/8
10 1/4	'30	10 1/8	—	6 3/4	6 1/2	7.80	18 1/2	33 1/2	28 3/8	25 1/2	52 1/2	36 3/8	61 1/8
8 1/2	'31	8 1/8	—	5 1/2	5 1/16	6.12	17 1/2	32 1/2	19 1/8	19 7/16	53 1/16	18 1/16	38 7/8
5 3/4	'32	8 1/2	—	4 1/16	4 1/4	5.47	17 3/16	28 1/2	21 1/16	17 1/8	57 1/16	17	38 1/8
5 3/8	'33	6 1/2	—	5 1/4	4 1/16	5.65	17 3/16	26 3/8	19 3/16	15 1/16	53 1/8	20 1/2	39 1/4
7	'34	5 1/8	—	4 1/16	4 7/8	5.71	17 1/2	25 1/16	17 1/2	13 3/8	62 1/8	21 1/2	42 3/4
7 1/2	'35	5 1/2	—	5 3/4	5 1/8	5.51	17 1/2	25 1/8	24 1/8	19 3/8	61 1/2	24 1/2	43 1/4
10 1/8	'36	5 3/8	—	6 1/4	6	6.47	17 1/2	27 1/2	23 3/8	19 1/2	70 3/8	28 1/2	48 3/4
16 9/16	'37	8 1/16	—	8 1/2	7 3/16	8.62	18 3/8	28 1/16	23 3/8	22 1/16	95 3/8	31 1/2	54 1/2
11 9/16	'38	7 1/2	—	6 3/4	5 1/16	6.35	14 1/16	24 3/8	17 1/8	14 1/2	68 1/8	26 7/16	46 3/8
12 1/2	'39	13 3/4	—	6 1/2	6 1/4	6.39	18 3/8	23 1/16	16 3/8	14 1/16	73 1/8	29 1/2	49 1/4
19 4/16	'40	17 1/2	—	8	8 1/2	8.50	25 3/8	23 1/2	22 3/8	19	114 1/2	44 3/8	66 1/2
21	'41	15 1/2	—	7 1/2	8 1/2	8.45	24 1/2	24 1/2	22 1/2	20 1/2	118	41 1/2	70 1/2
21	'42	16 1/2	—	8 3/8	9	9.25	26	26 1/8	24 3/8	23	118	44 3/8	78 3/8
21	'43	16 1/2	—	8 7/8	9 1/16	9.49	27	24 1/16	34 1/2	36	118 †	48 1/2	109 1/2
21	'44	16 1/2	—	10 1/16	9 3/8	10.14	27	28 1/2	43 1/2	42 1/2	118 †	60 1/2	107 1/2
21 1/16	'45	16 1/2	—	10 1/8	9 3/8	9.42	25	31 1/8	43 1/2	42 1/2	150 †	62	109 1/2
20 7/16	'46	44 1/2	—	17 1/2	15 5/8	11.73	29	38 1/2	46 1/2	43 3/8	270	87 7/8	130 1/2
22 7/16	'47	31 3/8	—	22 1/2	19 7/16	21.71	40	58 3/8	57 1/2	89 3/8	330	193 1/2	211 1/2
33	'48	23 1/2	—	20 3/8	20 1/16	20.72	43 3/8	64 3/8	60	99 1/2	329	193 1/2	216 1/2
38 3/8	'49	25 1/2	—	21 1/16	20 7/16	21.43	45	69 1/16	60	99 1/2	320	149 3/8	197
65 1/2	'50	38 1/16	—	28 1/16	26 1/8	27.08	58	71 1/16	80 1/2	100 1/16	322	132 1/16	243 1/2
	Average												
10 1/4	1904-13	11 1/2	—	9 5/8	7 1/2	6 7/8	16	17	31 1/2	31 1/2	43 1/2	26 5/8	49 1/2
10	1890-99	11 1/2	—	6 1/2	5 1/2	5	13 1/2	13 1/2	25	24 1/2	35	19 1/2	38
11 1/4	'78-87	15	—	8 5/8	6 3/4	6 1/2	15	17	35 1/2	32 1/2	40	23	46
19 1/4	'67-77	23	—	9	7	6 7/8	16	18 1/2	45	39	50	30	60

Index Numbers (or Percentages) of Prices, the Average of 1867-77 being 100

		Index Numbers (or Percentages) of Prices, 1913=100											
49	1922	125	1,075	114	174	77	89	151	127				
81	'29	60	976	129	166	64	89	144	122				
54	'30	48	669	92	150	43	65	104	110				
43	'31	39	504	77	146	47	51	108	63				
29	'32	35	513	66	132	44	45	114	61				
30	'33	29	534	68	127	39	40	108	67				
35	'34	24	572	67	123	55	35	124	71				
37	'35	24	641	69	125	52	50	123	75				
53	'36	25	646	82	129	52	51	140	85				
86	'37	37	745	109	134	39	58	192	95				
60	'38	35	601	81	110	36	38	137	81				
62	'39	57	741	84	119	49	37	148	88				
98	'40	76	1,191	109	141	50	49	228	122				
106	'41	68	1,300	107	135	54	53	236	124				
106	'42	70	1,304	116	150	76	59	236	137				
106	'43	70	1,327	120	149	81	92	236	176				
107	'44	70	1,460	132	161	97	108	236	187				
105	'45	70	1,515	129	161	97	108	300	190				
114	'46	193	1,848	199	194	103	111	540	243				
167	'47	136	2,359	277	284	129	230	660	450				
194	'48	102	2,787	271	311	133	254	658	456				
333	'49	110	2,849	279	328	133	254	640	385				
	'50	166	3,927	360	373	178	257	644	417				

* Common New Style from 1921 to 1936. China, Extra "A" from 1937-46; Japanese from 1947. † Nominal.

Digitized by Arya Samaj Foundation, Chennai and eGangotri

Average Prices of Commodities—Contd.

No. of Article	41A †	41B †	41C †	41	42	43	44	45A	45B	35-45	20-45	1-45
	Petroleum *				Soda		Indigo	Timber				
Year	Motor Spirit c.i.f.	Kerosene (Burning Oil) c.i.f.	Gas Oil c.i.f.	Mean of 41A, 41B and 41C	Crystals	Nitrate of Soda	Bengal, Good Consuming	Hewn, Average Import Price	Sawn or Split, Average Import Price	Sundry Materials Total	Materials Total	Grand Total
	d. per imp. gall.	d. per imp. gall.	d. per imp. gall.		s. per ton	s. per cwt.	s. per lb.	s. per load	s. per load			
1922 ..	15.89	6.32	3.98	—	123	14½	9½	46½	117½	—	—	—
'29 ..	6.75	4.87	3.21	—	100	10½	5½	44½	107½	—	—	—
'30 ..	6.52	4.54	3.21	—	100	9½	5½	44½	102½	—	—	—
'31 ..	3.63	3.10	2.33	—	100	9½	5½	37½	83½	—	—	—
'32 ..	3.97	3.34	2.39	—	100	8½	5½	35½	75½	—	—	—
'33 ..	3.43	2.94	2.48	—	100	8½	5½	31½	75½	—	—	—
'34 ..	3.28	2.65	2.45	—	100	7½	5½	31½	79½	—	—	—
'35 ..	3.51	2.88	2.32	—	100	7½	5½	32½	73½	—	—	—
'36 ..	3.77	2.76	2.34	—	100	7½	5½	37½	78½	—	—	—
'37 ..	4.52	3.71	3.14	—	100	7½	5½	58½	103½	—	—	—
'38 ..	4.08	3.49	3.22	—	100	8	5½	61½	94½	—	—	—
'39 ..	5.00	3.71	3.61	—	100	8½	5½	57½	107½	—	—	—
'40 ..	5.79	5.68	5.31	—	100	9½	5½	106½	169½	—	—	—
'41 ..	6.97	5.95	5.93	—	100	13½	5½	191½	214½	—	—	—
'42 ..	7.77	7.00	7.07	—	102½	13½	5½	235½	236½	—	—	—
'43 ..	8.93	7.51	7.61	—	107½	13½	5½	269	246½	—	—	—
'44 ..	8.31	6.78	6.83	—	107½	15½	6	222½	273½	—	—	—
'45 ..	6.23	5.33	5.38	—	107½	15½	6	190½	235½	—	—	—
'46 ..	5.81	5.21	5.20	—	107½	16½	6	184½	258½	—	—	—
'47 ..	7.69	6.83	6.52	—	107½	17½	7	187.43	289.20	—	—	—
'48 ..	9.38	8.74	8.69	—	107½	19½	7	215.02	352.82	—	—	—
'49 ..	9.61	8.51	7.78	—	107½	20½	7	207.09	354.37	—	—	—
'50 ..	11.67	10.55	9.84	—	107½	21½	7	228.33	380.46	—	—	—
Average 1904-13	BASE, 1922			—	60	10½	3	38	56	—	—	—
1890-99				—	53	8½	4½	40	45	—	—	—
'78-87				—	62	12½	6	47	47	—	—	—
'67-77				—	92	14	7½	60	54	—	—	—

Index Numbers (or Percentages) of Prices, the Average of 1867-77 being 100

	†	†	†									
1922 ..	100	100	100	100	134	102	128	143	1,339	3,408	5,873	
'29 ..	42	77	81	67	109	73	76	134	1,190	3,047	5,143	
'30 ..	41	72	81	65	109	70	76	129	1,034	2,487	4,313	
'31 ..	23	50	60	44	109	65	76	106	890	2,094	3,673	
'32 ..	25	53	60	46	109	62	76	97	855	2,062	3,571	
'33 ..	22	47	62	44	109	60	76	94	837	2,121	3,529	
'34 ..	21	42	62	42	109	56	76	97	839	2,176	3,635	
'35 ..	22	46	60	43	109	54	76	92	871	2,298	3,745	
'36 ..	24	42	60	42	109	54	79	102	925	2,414	3,945	
'37 ..	28	59	79	55	109	56	79	142	1,081	2,821	4,581	
'38 ..	26	55	81	54	109	57	79	136	921	2,471	4,071	
'39 ..	31	60	91	61	109	58	79	145	964	2,663	4,247	
'40 ..	36	90	133	86	109	70	79	243	1,285	3,645	5,760	
'41 ..	44	94	150	96	109	93	79	356	1,438	4,004	6,379	
'42 ..	49	111	178	113	111	96	79	413	1,564	4,153	6,812	
'43 ..	56	119	199	122	117	96	79	452	1,715	4,354	6,978	
'44 ..	52	107	172	110	117	109	83	436	1,776	4,619	7,221	
'45 ..	39	84	135	86	117	109	83	373	1,753	4,730	7,375	
'46 ..	36	82	131	83	117	115	83	389	2,177	5,696	8,365	
'47 ..	48	108	164	107	117	128	97	418	2,897	7,382	10,353	
'48 ..	59	138	218	138	117	141	97	498	3,074	8,435	11,683	
'49 ..	60	135	195	130	117	146	97	493	3,002	8,524	12,342	
'50 ..	73	167	247	162	117	155	97	534	3,294	10,134	14,598	

* Prior to 1922, Kerosene Burning Oil (in barrels), base period 1873-77; from 1922 c.i.f. values per imperial gallon of Motor Spirit, Kerosene (Burning Oil) and Gas Oil, base period 1922.

† Index-numbers not included in the general average.

1951]

REVIEWS OF STATISTICAL AND ECONOMIC BOOKS

CONTENTS

	PAGE
1.—Statistical Office of the United Nations. Index Numbers of Industrial Production	423
2.—National Bureau of Economic Research. Conference on Research in Income and Wealth	423
3.—Klein (L. R.). Economic Fluctuations in the United States, 1921-41	425
4.—Paish (F. W.). The Post-War Financial Problem and other Essays	427
5.—Morgenstern (O.). On the Accuracy of Economic Observations	428
6.—Butterbaugh (G. I.). A Bibliography of Statistical Quality Control: Supplement	430

1.—*Index Numbers of Industrial Production: Studies in Methods No. 1.* Statistical Office of the United Nations, New York, 1950. 60 pp. $10\frac{1}{2}'' \times 8\frac{1}{2}''$. 25 cents.

The objects of this study are "to provide guidance on matters both of basic concepts and of statistical practice to individual countries compiling or planning to compile index numbers of production" and "to assist in securing international comparability between national index numbers". It has been compiled by the Statistical Office of the United Nations with the help of Professor R. G. D. Allen as expert consultant. As is shown by the bibliography appended to this pamphlet, studies on this subject have been confined hitherto almost entirely to British and United States statisticians; this study should therefore be of value to the increasing number of countries compiling such indexes.

The study discusses the scope of the index, the grouping of the industries covered, the determination of the weights and the selection of the series (of quantum data) to measure current changes. It points out that complete data necessary for an accurate index of changes in the volume of work done are unlikely to be available even from censuses of production, and shows that an approximate series can be constructed from the available data in many censuses of production by valuing net output at constant prices of products and materials, as suggested by Dr. Geary in this *Journal* (vol. cvii, Parts III-IV, 1944). The problem of long-run comparisons and the linking of short-run series, the use of sampling methods, and the relation of index numbers of production to national income accounting and to other general economic indicators form the subject of other sections. A technical appendix gives the various formulae suggested in the text with special sections on the measurement of productivity of labour.

J. W. NIXON.

2.—*Studies in Income and Wealth. Vol. XI: Conference on Research in Income and Wealth.* New York: National Bureau of Economic Research, 1949. xii + 450 pp. 9". \$6.

This volume of American conference papers is rather less homogeneous than many others in the series, and must be reviewed piecemeal. It starts with technical and very full accounts by Solomond Fabricant and Daniel Carson of the historical changes in manpower distribution in the United States. The next paper, by Nathan Koffsky, compares U.S. farm and urban living standards, and reaches conclusions which suggest that some U.S. discussions about farm "parity" which exclude relative living costs are of rather restricted significance.

The next essay, by Mr. Hans Staehle, is also concerned with measurement of living costs. Being dissatisfied with the usual methods of international comparisons, on the grounds that they postulate identity of wants in the countries concerned and that they necessitate substitution of commodities in the calculations (e.g., rye bread for wheat bread), Mr. Staehle outlines his "Dissimilarity Method". In view of the importance of new attempts to provide a satisfactory price index this method will be discussed at some length. It starts by comparing the proportionate consumption patterns in two different average household budgets. The "Dissimilarity" is measured by calculating the difference between (i) the ratio of quantities of meat, e.g., in the two budgets, and (ii) a general quantity index for the budgets, expressing this difference as a proportion of the quantity index, and then finding the weighted average of these relative deviations for all commodities. In an international comparison this "Dissimilarity" is calculated between the

average budget corresponding to an income level in one country and the average budgets of different income levels in the other country, and then repeated for other income levels in the first country, so that a whole matrix of "Dissimilarity" coefficients is built up, one for each pair of budgets. The surface of this matrix is then explored for a "valley", where the Dissimilarity is least, and the corresponding incomes in the two countries are taken to be "approximately equal in satisfaction", so that a cost-of-living comparison is immediately yielded. Mr. Staehle lists several objections to the method, notably its lack of theoretical justification. Even though he believes countries with rationing can be brought into his comparisons, it is obvious that countries suffering from shortages cannot. Further, the coefficient would be sensitive to the commodity classification used; and as in the examples he shows, the minimum "Dissimilarity" may be close to other values of the coefficient which would imply quite different index numbers—i.e., the "valleys" have relatively wide floors. Would a small decrease in the coefficient (compared to its size) really be a pointer towards equivalence in living standards? But apart from these specific difficulties, would one actually have reason to presume that real incomes and consumption patterns were in close association internationally? Social influences are very complex and varied. In one country they may induce increases in real incomes to take the form of more food: while in another living standards may evolve towards more socially conspicuous consumption, such as more ornate vehicles or clothing, and one cannot be at all sure *a priori* how the "Dissimilarity" coefficient would behave. Mr. Staehle's method is at least suggestive, and any pointer is welcome in this barren landscape of international comparisons. One would not however know, without extensive experience in its use, just what conclusions one could safely draw.

The last two papers (by Mr. Sapir and Mr. Modigliani) are on economic forecasting. The former reviews the main forecasts for the transition period in the United States, from the standpoint of one who, as a member of the Bureau of the Budget, had a hand in official forecasting. These forecasts represented perhaps the first attempt to apply modern quantitative analysis to a question of supreme importance for economic policy—namely, whether the general tenor of the transition would be deflationary or inflationary. Unfortunately for the prestige in America of economics, or at least Keynesian economics, most of these forecasts were somewhat inadequately qualified and turned out to be disastrously wrong. Mr. Sapir starts by comparing the forecasts with "actual" developments—or what should be described in these discussions more accurately as official estimates of actual developments. (Published estimates always seem to undergo a curious apotheosis into literal truth.) One of the main sources of error is found to be in the forecasts of "autonomous" expenditure, notably capital expenditure, and the question is rightly raised of the extent to which such items are in fact "autonomous". A second important cause was that disposable income *for a given national income* was underestimated, though this was because of changes in taxation and transfer policy, which could hardly have been anticipated (and were in part due to the forecasts themselves). Any model can only represent the working out of certain assumptions about policy, and for this reason the term "forecast" might well be avoided. Thirdly, consumer expenditure was substantially more than expected. The paper concludes with a very frank admission of the failure to judge the economic climate correctly ("Looking backward, it seems incredible that we could have missed the signs so badly.") The reader is driven to conclude that this statistical debacle was one more illustration of the truth that an ounce of economic judgment is worth a ton of diagrams and regression equations. A comment by Laurence Klein, who had more success with his own forecasts, curiously suggests that error margins with probability measures can be ascribed to forecasts from models because the average variations due to "disturbances" (such as strikes, shortages, etc.) "can be estimated from the past behaviour of the system"!

The last essay, by Mr. Modigliani, examines the problem of forecasting consumption at much greater length. His thesis is in brief that parameters estimated from a period in which both cyclical and secular changes were operating can be very dangerous for forecasting. He defines a "secular" movement as one "that carries real income *per capita* above the highest level reached in any preceding year" (p. 379)—a definition that is slightly unusual. Still, whatever labels he uses, the regression equation that results from his approach relates consumption not only to current national income, but also to the *highest previous* national income, an addition for which there is much common-sense justification, because of the downward inflexibility of living standards. This equation implies a very important distinction between the long-run marginal propensity to save, which he estimates at .10, and the cyclical marginal propensity, which he puts at .23. Here he finds the clue to the underestimate of consumption in the models previously discussed, because the model-builders were applying in effect a composite marginal propensity to save higher than the "secular" one which was really appropriate. Mr. Modigliani successfully tests his thesis from Swedish and Canadian data. He also shows that a useful distinction can similarly be made between secular and cyclical factors in explaining movements in the share of corporate

1951]

profits in national income, and thus in corporate savings. The paper ends by drawing attention to the wider importance of "irreversibility" in economic relations, but his conclusions on the economic implications of his analysis are of greater interest. The high marginal propensity to save, which was previously believed to exist, had implied that a high level of employment could only be maintained in America by increasing recourse to stimulants such as budget deficits and overseas investment. These seemed to be needed as offsets to the rapidly growing savings that would be generated by the productivity increases of which the American system was capable. Alternatively, if the marginal propensity to save were not high, "the Multiplier" would be large and violent short-term fluctuations could be expected.

After Mr. Modigliani's paper, the economist's view of the American scene is made more optimistic by the demonstration from past data that there may well be a high short-run and a low long-run marginal propensity to save, though as Mr. Modigliani sees (p. 428), the problem of maintaining full employment in the U.S. does not entirely vanish. A second important consequence of his analysis is that the model-builder can hardly fail in the future to distinguish between short-run and longer-run influences. For these reasons Mr. Modigliani's paper is of major importance.

DUDLEY SEERS.

3.—*Economic Fluctuations in the United States 1921-41*. By Lawrence R. Klein. New York: John Wiley, 1950. (London: Chapman & Hall.) xi + 174 pp. 9". 32s.

Econometricians are commonly criticized because the balance between their theoretical and empirical work is so heavily weighted in favour of the theoretical. This monograph will please the critics because it helps to redress the balance. Klein concentrates on the economic significance of his work; only a bare outline of the statistical methods is given; and even the computations are to be published later elsewhere. The statistical aspects of this type of study are dealt with in monograph 10 of this Cowles Commission series. Nevertheless this work is of particular interest to statisticians because it represents the first application of the methods of stochastic simultaneous equation estimation developed largely under the auspices of the Cowles Commission.

The basic idea of the work is that changes in the economy can be explained by a relatively small number of linear equations in a few macro-economic variables, once there are given the values of a certain number of lagged endogenous variables or of exogenous variables whose behaviour is determined by non-economic forces or whose behaviour the model does not attempt to explain.

Klein presents three main models. The first is intended primarily as an exercise in the techniques, and consists of three behaviour relationships: a consumption function which depends on profits and wages, an investment equation depending on profits and the stock of capital, and a wage bill schedule depending on national output plus a time trend. These three schedules, which exclude the government sector, plus three definitional equations in the endogenous variables, enable us to find the values of consumption, investment, profits, wage bill and the national income once the stock of capital, government output, indirect taxes and some values of lagged endogenous variables are given. The effect of introducing lagged profits in the consumption function is studied and the multiplier effect of a government spending obtained.

The second model has only one behaviour equation, namely the consumption function, and is used to discover whether the experience of 1921-41 suggests that the stock of cash balances and lagged income have significant effects on consumption. Klein concludes that the effect of cash balances is not significantly different from zero.

The third model is much more complicated and is meant to be a much nearer approach to real conditions—there are twelve behaviour equations and three definitions connecting thirty variables. The three equations of model I form a basic part of the structure, but are refined by adding extra equations to explain the separate components of investment—plant and equipment, inventories, housing. Three extra equations include the movement of active and inactive money balances and the interest rate. A further introduction is an equation covering the adjustment of output to unexpected inventory movements and price changes. Money balances do not occur in the consumption function, following the conclusion of model II, or in any other equations, and thus money balances are in fact symptomatic only and do not influence the movement of the other variables.

Klein justifies the form of the equations by starting from micro-economic theory on the behaviour of firms and households, and not merely because they in fact give sensible results to the computations. From micro-economic theory assuming profit maximization and perfect competition, assuming that expectations may be represented as a linear difference equation in the variables over a number of periods, and assuming the existence of a Cobb-Douglas production function, he obtains a linear behaviour equation. Aggregation over the various household and

business units is assumed not to alter the form of the equations significantly. The effect that other economic conditions such as imperfect competition, asset stabilization, etc., would have on equations are discussed, but given the large amount of computational effort required, it is not surprising that only one fundamental pattern is used. The number of possible variations is so great that these chapters necessarily give the impression of posterior justification. Nevertheless, they are of interest to economists and it is important that this approach should be developed.

The equations are estimated by using the least-squares technique as well as by the newer methods, and a comparison of the results is of particular interest because the latter comprise one of the very few cases where novel statistical techniques have been first developed to deal with the special problems of economics. The older least-squares method assumes only one dependent variable as is usual in experiments, but the economist's data do not usually come from controlled experiments and his estimation problems are different. For example, when dealing with price and quantity relations, two equations, the supply and demand functions, are in operation simultaneously, and both price and quantity are dependent variables.

The new approach forces the economist to specify more completely a whole model of the economic system even if he is interested only in estimating one relationship—say a demand curve. Another of its features is that the equations have an error term that represents the error in the equation, not an error in a variable. This error, which is usually taken to be a normal variate, represents either a random element in the nature of the law or those variables whose effects have not been isolated in the model. The error terms may be correlated with the dependent variables or with error terms in other equations. This will, for instance, be so in general if the term is looked upon as representing the effect of omitted variables.

The results that Klein obtains using the least-square and the simultaneous equations approach turn out to be remarkably similar, which, considering the arbitrary selection of a dependent variable and the bias known to occur in least-squares estimates, is surprising. There are, however, many statistical problems which have not been solved; the data used are usually highly serially correlated, although the methods used assume that the errors in the equations are serially independent. The errors can be particularly large when data have to be reclassified into a form very different from the original—for example, when income is classified according to whether it accrues to labour or capital. The dangers of possible "multi-collinearity" are not skirted by the new methods. In addition the total number of observations is small, and in the periods for which data exist and in which it can be assumed that the endogenous relationships remain reasonably constant, it is not certain that there is sufficient variation of the exogenous variables to reveal to the statistician the relationships present. Moreover, the superiority of different methods of estimation is shown only for large samples.

In view of the complexity of the problem and the large number of assumptions that necessarily have to be made, no system or results are likely to be trusted until they have passed the test of successfully predicting events. Unfortunately, after performing such heroic feats of calculation and presenting so much careful study, Klein has not subjected his models to the acid test of successful prediction. This is especially to be regretted, as on the first page it is stated that the objects of the study are to obtain knowledge "for forecasting and making policy recommendations", and that "too often writers have made bold statements about the operation of the system without examining the factual data to determine whether or not their statements are true. As a result we have had continuing economic fluctuations and continuing publication of business cycle theories".

In the preface Klein states that pre-war relationships do not seem to hold over the war period and the consumption function is the most wayward relationship and needs revision. (C. Clark's observations on the need to consider the long-term trends may be important here.) But if it is true that the pre-war structure has been changed significantly, is it reasonable to assume that the structure was constant throughout the depressions of the inter-war period? It might have been better to have omitted some inter-war years, and compared these with what the structure based on the remaining years predicted even at the cost of further reducing the small sample.

One fortunate result for a reviewer of the long delay between a book's preparation and its printing is that research workers have time to re-examine the field before the book is distributed. Christ of the Cowles Commission in a dissertation has tested whether 1946 and 1947 give results significantly different from those suggested by Klein's structure. With the exception of the consumption function the results are not significantly different, and so Christ uses the data 1921-1941 plus 1946 and 1947 to obtain a structure to predict events in 1948. These predictions are compared with those of two "naïve" hypotheses which were suggested by Professor Milton Friedman. These are first that events next year will be the same as this year, and secondly that the change from one year to the next will be repeated the following year. These "naïve" hypotheses predicted better than the more elaborate structure in seven cases out of thirteen—there seems nothing to

1951]

choose between the "naïve" hypotheses for the 1948 prediction. Such results obviously provide the practical man with ammunition against critics of his rule-of-thumb methods. It may be, however, that any simple auto-regressive scheme would have predicted 1948 events, but that more elaborate structures are needed for predicting turning-points in cycles.

This monograph, partly because the estimates have not been subjected to the test of attempted prediction, gives the impression of being finished rather hurriedly, and this would not be surprising considering the vast amount of work done. It would have been an advantage to have had a discussion on improvements obtained by making the models more complex, rather than by presenting the models so separately—even the same symbol often has a different meaning in the various models. The effect on the estimation of common variables of introducing the extra markets could have been discussed—it seems to improve them. It would also have been a great advantage to the reader to have a much clearer idea of the lessons which Klein has learnt from this work, especially as in the preface he says that if he had to start again he would proceed differently.

Klein believes that the models give a reasonably good description of the pre-war economic process, but does not discuss the question whether the residuals are such that the equations, even if correct, form a sufficiently firm basis for anti-cyclical measures. The residuals are indeed large and, with a multiplier around two, would require a very elastic government investment programme to keep the economy on an even course.

This whole subject is still in an experimental stage, and it may be that the grand endeavour of this work has placed too great a burden on methods which will yield immediate results, given more modest aims. This could not be known in advance and this was an endeavour well worth attempting. It is to be hoped that this approach to economic problems will be developed, and that the Cowles Commission, as parent of most of the work in this field, will not leave it until it has been more thoroughly explored.

G. PENRICE.

4.—*The Post-War Financial Problem and Other Essays.* By F. W. Paish. London: Macmillan, 1950. x + 263 pp. 8½". 15s.

Professor Paish has collected five post-war and seven pre-war or early wartime essays, of which all bear reprinting and re-reading, and several offer excellent material for jobbing backwards. The essays of most topical interest are two which deal with the post-war balance of saving and investment. The first of these, published in February, 1947, "The Post-War Financial Problem", might well serve as source material for the economic history—which is about due—of the post-war transition. Professor Paish there makes an estimate of the demand for investment in the first ten post-war years and of the possible sources of saving. The records are now available for five of the ten years. Quantitatively, Professor Paish was badly out (unless the next five years completely contradict the experience of the first). But he analysed accurately the nature of the problem. He put the total domestic capital formation in 1946–55 at £10½ billions ("minimum") to £12½ billions ("likely"). In fact, it has been over £8 billions in 1946–50 (exactly how much depends on how much building repair and maintenance work he intended to classify as investment). His under-estimate is partly explained by the rise in prices of investment goods, particularly in the one kind of investment for which he makes a specific estimate—new houses. (He expected 300,000 a year, thinking housing would be "at the head of the list" among Government-sponsored programmes. In physical terms this estimate was 50 per cent. too high for the first five years, yet in terms of value it has been about realized.) But in other fields the rise in prices of investment goods has probably not been sufficient to account for a great part of his under-estimate.

Like many other forecasters, official and unofficial, Professor Paish under-estimated the forces of expansion which a period of full employment would release. It may be argued that the physical expansion has been accompanied by a persistent inflationary pressure, and that Governments have not yet been able to reconcile full employment with preventing inflation. It may also be argued that much of the expansion of investment and output has been in the wrong directions. Nevertheless, the physical expansion has taken place.

Professor Paish, rightly ruling out a substantial rise in interest rates as improbable, and general restriction of consumption as wasteful and ineffective, advocated substantial budget surpluses as the only satisfactory way of enabling even his estimate of investment to be financed. This solution did not seem very likely in early 1947. The watershed in post-war economic policy was marked by the Emergency Budget of autumn, 1947, after the dollar crisis of that summer, and is analysed in a second article on "Savings and Investment", published in November, 1948. The emergency action then taken was intended to turn the budget deficits into a true surplus—which it did; to reduce total domestic investment—which it did not; and, by restricting home demand, to remove the balance of payments deficit—which it did.

At the time, however, Professor Paish was troubled by the apparently excessive strength of the deflationary elements. On the statistics, the cut in investment and the increase of Government saving would together enable investment to be financed with no "personal" saving at all. Unemployment should therefore be appearing. It later became clear (as Professor Paish suspected) that the cuts in investment never happened on anything like the scale announced—partly because of explicit relaxation of Government restrictions, partly because the greater part of investment in plant and machinery, and some investment in building, was in any event uncontrollable. Thus total fixed investment was in fact substantially greater in 1948 than in 1947. The whole incident has two morals: first it shows the bluntness of the weapons at the disposal of the authorities; second it shows that even a year after the introduction of a radical change in policy, it was impossible from published statistical data to see at all precisely what was happening at two central points in the system—the development of the true budget surplus and the trend of total investment.

An essay on "Forecasting Foreign Trade", published in 1937, described a method of determining the time-lag between a change in the export receipts of a primary producing country and the corresponding change in imports—studying the intervening changes in foreign assets, bank deposits and advances. This technique could be of considerable practical value to exporters if our customers—especially the primary producing countries—should cease to "plan" their imports, and if their total purchasing power (and not just bilaterally arranged releases of sterling balances and dollar "rations") should once again determine their offtake of our exports. Even now, one feels that something could be learnt by application of the technique: for example by a study of recent developments in the connection between Australia's overseas receipts—especially the annual "wool cheque"—and her propensity to import. The customer's purchasing power still plays some part in our exports; indeed in certain cases bilateralism and inconvertible currency make it regrettably simple to forecast a country's propensity to import not only in total but from a specific source.

Much the same theme is expanded in an article of 1936 on "Banking Policy and the Balance of Payments", which shows the ways in which the banking mechanism can act to correct a balance of payments position. Control of credit through the banking system, Professor Paish points out, can operate speedily and effectively in a country with a high marginal propensity to import: this normally means a primary producing country, and is relevant to the balance of payments problems of such countries in the early thirties. But in an advanced industrial country, with much "fat" in the system, credit restrictions can affect imports only slowly and painfully—in fact, by restricting purchasing power in general. This statement of the problem, which became familiar in the thirties, is becoming relevant once again. An obvious application is to Germany's debtor position in E.P.U.; it is still thought in some quarters that general credit restriction—through an unwieldy banking system—is the best method of correcting the balance of payments of a country which is by no means in a state of full employment.

In addition there are three post-war papers on "Cheap Money Policy", "Planning and the Price System", and the "Economics of Rent Restriction". There are also earlier essays on "Causes of Changes in Gold Supply"; a useful reference work embodying a good deal of practical research on "Twenty Years of the Floating Debt" (1939), with an analytical interpretation of "British Floating Debt Policy"; a short note on "Capital Value and Income"—which is relevant to the economic effect of dividend limitation—and an essay on "Economic Incentive in Wartime".

C. T. SAUNDERS.

5.—*On the Accuracy of Economic Observations*. By Oskar Morgenstern. Princeton: Princeton University Press, 1950. ix + 101 pp. 10". 12s. 6d.

This substantial pamphlet by Professor Morgenstern is both timely and stimulating, but it is also in many respects unsatisfactory. Now that economists are more often embarrassed by the extent and the variety of economic statistics, rather than by an absence of information about the topics that interest them, it is certainly desirable that they should be more discriminating in the way that they manipulate their raw material. Professor Morgenstern has, therefore, performed a useful service in suggesting that it is time that there was a change of emphasis in economic statistics. Serious attention should now be given to the kinds of error that arise in different sorts of economic observations, and the question of whether many economic statistics will really support the wealth of refined analysis often superimposed on them should be carefully examined. Until this has been done, not only will much economic analysis tend to mislead the public—Professor Morgenstern does not consider this a serious danger, since the public usually have a healthy distrust of economic statistics and of the purposes to which they are put—but, more serious still, a large number of economists and statisticians will be wasting their time. This is a proposition with which many people will sympathize, and conscientious users of economic statistics

1951]

will be eager to follow up any of the hints that Professor Morgenstern lets drop so that standards of analysis may be raised.

Such hopes are, however, doomed to disappointment. Professor Morgenstern states his general proposition with some force and enumerates at length the kinds of error that may arise, but when he demonstrates his points with specific illustrations his arguments appear naive and to lack conviction. At many stages in his discussion he damages a good case by a tendency to exaggerate the extent to which particular statistics are meaningless. It may be true that estimate of the National Income and its components, even in advanced countries, only measure what they purport to measure, subject to an error of $\pm 15-20$ per cent., but it does not follow therefrom that a statement that consumers' expenditure has risen by 1 per cent., say, during the past year is necessarily meaningless. The fact that estimates of absolute size have a wide margin of error does not automatically imply that year-to-year changes are subject to the same error.

Professor Morgenstern's treatment of errors from a theoretical point of view suffers from two serious omissions. He fails to distinguish in his argument between that part of an error which consists of a constant bias, that part which is purely random and that part which may vary with some extraneous economic or other variable. Instead he concentrates his attention on the absolute magnitude of the error. Also he breaks off his analysis too early, for neither the size nor the character of the error is important *per se* but only in relation to the use to which the particular set of observations is put. Considered from this point of view the importance of errors in various economic observations taken on their own pales into insignificance beside the far more complex problem of whether the errors in a whole array of observations, of different but related phenomena, are such as to lead to the adoption of misguided economic policies. Or, to put the matter another way, the relationship between the errors in the various observations is of greater concern than the magnitude of the errors in the individual items.

At a more mundane level, it is not altogether clear whether Professor Morgenstern's anger at the unreliability of economic statistics is directed against the compilers of primary statistics for not measuring more accurately what they say they measure (or would say that they were measuring, if contact between compilers and users could be more satisfactorily established), or for not measuring what economists would like them to measure. There is at least something to be said against economists who assume that what has been measured necessarily accords with their own definitions, and Professor Morgenstern does not appear entirely guiltless in this respect. For when in the second part of his work he considers the statistics of Foreign Trade generally and of Mining, Agriculture, National Income, Employment and Prices in the United States in more detail he often makes little attempt to allow for differences in classification. This is particularly true of his extensive analysis of the errors in Foreign Trade statistics, where he accepts the raw data provided by various countries and makes no adjustment whatever to allow for differences in definition, in methods of valuation or for differences due to time lags. The use of economic statistics is normally accustomed to make these corrections, and his interest is centred in the irreducible element of error that remains and not in the gross error that exists if he fails to do his duty. This demonstration of Professor Morgenstern's lack of statistical expertise considerably detracts from the force of his apparently considered judgment that the Balance of Payments includes "pure guesses of the most doubtful character", an allegation which he makes not the slightest attempt to justify.

The argument that, since earlier official estimates of United States National Income have been subject to less extensive revisions than later figures, the quality of the estimates has deteriorated rather than improved should not be allowed to carry much weight and is clearly illogical. The gradual extension of the sources from which National Income estimates can be derived, and the increased cross-checking that this allows, must of necessity increase the scope of possible revisions as later information comes along. To lull Professor Morgenstern's suspicions, either the publication of National Income estimates would have to have been delayed until they had little or no value, or else preliminary estimates once printed would thereby become sacred and inviolable. Neither course could make much contribution to the cause that Professor Morgenstern has espoused.

It is perhaps noteworthy that nowhere does Professor Morgenstern discuss the extent to which reliability should be sacrificed in order that information should arrive in time to be useful. For those who research at leisure this may seem an unimportant problem, but if policy decisions are to be taken at the right time and supported by a sound system of economic intelligence it has profound practical significance.

In general Professor Morgenstern's examination of the nature of errors in economic observations is more illuminating than his attempts to give practical content to his ideas. It would be especially interesting if he developed his few remarks about the concealment and distortion of statistics and the relation of this problem to a non-strictly determined two-person game. Even

if Professor Morgenstern's strictures cannot all be taken at their face value, it is abundantly clear that he is right in emphasizing both the difficulty of the problems arising from errors in economic observations and the need to take them much more seriously than has been the practice in the past. If Professor Morgenstern persuades even a small proportion of those who use economic statistics to re-examine their attitude to errors, we shall be deeply in his debt. A. D. ROY.

6.—*A Bibliography of Statistical Quality Control: Supplement.* By Grant I. Butterbaugh. Seattle: University of Washington Press, 1951. 141 pp. 9". \$2.

Dr. Butterbaugh's original bibliography was published in 1946. It included 712 articles, manuals or books published between 1924 and 1945 by about 340 different authors. The articles appeared in 137 different periodicals. Brief abstracts accompanied the titles of all but a few of the items.

Not content with this Gargantuan feat, the author has continued his list in the present *Supplement*, which covers the period up to June, 1949, and contains about 725 items. These figures illustrate the difficulty which the author confesses to having met in deciding which articles should be included in the *Supplement*. From the start he interpreted the term "quality control" in a very wide sense, including in his list almost any application of statistical methods to industrial problems, and also a number of relevant theoretical papers. Apart from the general spate of papers in the post-war period, the most important event has been the launching of *Industrial Quality Control*, in which journal alone 127 of the listed articles appeared. The bibliography is, in fact, being carried currently in *Industrial Quality Control*.

The high standard of the original volume is maintained in the *Supplement*. As in the original, the list is divided into three parts (for articles, manuals and books), the first part being arranged in alphabetical order of journals. An author index and a subject index are included, the latter conveniently covering both the original volume (which had no subject index) and the *Supplement*. P. ARMITAGE.

1951]

STATISTICAL NOTES

(1) BRITISH OFFICIAL STATISTICS

The interim index of retail prices compiled by the Ministry of Labour and National Service rose from 121 in April to 124 in May and 125 in June. The increase in May was due mainly to higher prices for many articles of food, for some household appliances, furniture, clothing, newspapers and, in many districts, beer. The average price of coal fell on the termination of winter prices.

The detailed figures for April to June were as follows:

(Prices at June 17th, 1947 = 100)

Date	Food	Rent and Rates	Clothing	Fuel and Light	Household Durable Goods	Miscellaneous Goods	Services	Drink and Tobacco	Total
Weights:	348	88	97	65	71	35	79	217	1,000
April 17th, 1951	130.6	103.7	134.2	128.3	127.7	122.6	115.8	104.3	121
May 22nd, "	135.4	103.8	136.7	126.9	133.2	130.2	116.3	106.6	124
June 19th, "	135.9	103.8	138.6	125.6	134.2	130.4	116.8	106.8	125

In publishing the figures, the Ministry of Labour states that they are in the form in which they are used in the procedure adopted for calculating the index for all the groups combined, i.e., to the nearest first place of decimals. The decimals are shown in order that, if desired, calculations can be made of the effect of combining particular groups and excluding others. The information available as to price changes, however, is such that no precise significance can be attached to the decimals, and for any other purpose, therefore, the figures should be used to the nearest whole number.

The Ministry of Labour index of weekly wage rates, which was 117 (June, 1947 = 100) in March, rose to 118 in April and 119 in June. The increases in wages affected mainly workers in the iron and steel industry, tailoring, the gas industry, pottery manufacture, printing and boot and shoe manufacture.

The total working population and the numbers in civil employment at recent dates, compared with mid-1948, when the new series of man-power figures started, have been as follows:

	Total Working Population			Numbers in Civil Employment		
	Males	Females	Total	Males	Females	Total
Mid - 1948 . . .	15,810	7,094	22,904	14,698	6,986	21,684
March, 1951 . . .	15,923	7,306	23,229	14,959	7,194	22,153
April, 1951 . . .	15,939	7,328	23,267	14,984	7,226	22,210
May, 1951 . . .	15,937	7,350	23,287	14,997	7,259	22,256

The level of unemployment has continued to fall steadily since January. The figures are analysed below:

Number of Unemployed Persons on the Registers of the Employment Exchanges of the Ministry of Labour and National Service

Date	Men and Boys	Women and Girls	Total
March 12th, 1951 . . .	182,882	91,979	274,861
April 16th . . .	164,908	88,044	252,952
May 21st, " . . .	141,964	73,718	215,682
June 18th, " . . .	125,463	65,313	190,776

The figures do not include registered severely disabled persons who are unlikely to obtain work other than under special conditions.

It is estimated that the number of unemployed persons on the registers at June 18th represented 0.9 per cent. of the total number of employees insured under the National Insurance schemes. The percentage in the Regions ranged from 0.3 in the Midlands and North Midlands to 1.8 in the Northern Region, 2.0 in Scotland and 2.2 in Wales.

The number of insured persons absent from work owing to sickness, including self-employed as well as employed was 902,700 in April, 790,500 in May and 805,900 in June. All these figures were lower than in the same months of 1950. The number of employed persons absent owing to industrial injury was 57,400 in April, 52,300 in May and 57,900 in June, these figures also being lower than in 1950.

The information now available in respect of employees insured under the National Insurance schemes has enabled the Ministry of Labour and National Insurance to compile a much more detailed analysis by ages than has hitherto been practicable. The published particulars are based on a sampling process which is described in the June issue of the Ministry of Labour Gazette. The following are the age-groupings at May, 1950:

	Males per cent.	Females per cent.
Under 20	7.5	17.9
20 to 39	45.0	45.7
40 to 59	43.9	32.5
60 and over	3.6	3.9

The grouping is shown to vary considerably in the different industry groups. The percentage of males under 20 to the total male employees was about 5 in chemicals, metals, gas, water and electricity and transport and under 5 per cent. in insurance, finance and public administration. On the other hand it was 12 per cent. in agriculture, 14 per cent. in woodworking and over 10 per cent. in printing, building and distribution. The proportions aged 65 and over varied in different industries from 2 to 6 per cent. The proportion of female employees aged under 20 varied from 10 per cent. in public administration and professional services to over 25 per cent. in clothing, printing and the distributive trades. The published summary also gives details with regard to the numbers of married women and analyses all the figures by industries and by Regions.

Fuel and power statistics.—When important industries are reorganized, it is appropriate that these events should be followed—after not too long an interval of time—by the necessary adjustments in the relevant statistical sources. The organization of the fuel and power industries has been very substantially altered in recent years. In 1942 Government responsibility for these industries was centralized in the Ministry of Fuel and Power, and the legislative trilogy of the Coal Industry Nationalization Act, 1946, the Electricity Act, 1947, and the Gas Act, 1948, resulted in the assets of the coal industry being vested in the National Coal Board on January 1st, 1947, while those of the electricity supply industry vested in the Electricity Boards on April 1st, 1948, and those of the gas industry vested in the Area Gas Boards and the Gas Council on May 1st, 1949. In accordance with the provisions of the Electricity Act, the Electricity Commissioners, who had previously been the main source of official statistics for the electricity industry, were dissolved on August 1st, 1948.

Nationalization created internal needs and opportunities for improved statistics within each of the three industries and their response is seen in the *Annual Reports and Accounts* of the National Coal Board, British Electricity Authority, Area Electricity Boards, Gas Council and Area Gas Boards, and in the statistical publications of the National Coal Board (*Coal Figures*, which is issued monthly, the *Quarterly Statement of Costs of Production, etc. of Collieries* and the statistical appendix of the Annual Report). The petroleum industry too has not escaped change in recent years; during the war and up to the middle of 1948 the operations of the companies engaged in the bulk distribution of petroleum were co-ordinated by the Petroleum Board, and when this was demerged, the statistics collected by it were continued by the United Kingdom Petroleum Industry Advisory Committee. Some of the most important of these statistics are now published annually on behalf of the Committee by the Petroleum Information Bureau.

Occupying, as it does, a central position, and possessing adequate powers to collect the statistical information it requires, the Ministry of Fuel and Power is well placed to consolidate the statis-

1951]

tics for the whole field of fuel and power, and the last issue of its *Statistical Digest* (Ministry of Fuel and Power Statistical Digest, 1948 and 1949, London: H.M.S.O., 1950, 197 pp. 11", 7s. 6d.) has been largely re-written and extended to take into account the changes in organization within this field in recent years and to make public new information not previously available. At the same time, the Ministry has improved the presentation of its statistics by adopting the new format used by the Central Statistical Office for the Annual Abstract of Statistics and by re-drafting many of the tables given in former issues of its Digest.

The main respects in which the new issue, which contains nearly 200 large pages, differs from its predecessors may be noted. Whereas previous issues were largely devoted to coal, the new Digest replaces the *Annual Returns* of the Electricity Commissioners and the *Return Relating to Authorised Gas Undertakings*, and it gives much more attention than previously to the electricity and carbonization industries. More information is also given about petroleum, and mention may be made of the series of tables dealing with the use of pulverized fuel and of the occasional tables which give long historical series of the more important statistics for each industry, some of them being taken back to 1853. Many of the detailed statistics are given for years back to 1943, and in some cases the tables include statistics for two-monthly periods, periods which have the advantage of being unaffected by the yearly changes in the incidence of Easter and Whitsun, and which can be added up, both into coal winters and summers, and into calendar half-years. New statistics are presented which derive from the revision of the Ministry's annual forms of return for 1948. The returns for that year were re-drafted with the object of improving the comparability of the statistics for the separate industries and to obtain, for all of these industries, information that had previously been available for only some of them. This re-drafting was done in such a way as to fit in with the requirements of the Census of Production, and make it unnecessary for the Ministry and the Census Office to collect overlapping information. The new issue of the Digest includes information comparable with that presented in Census of Production reports about capital expenditure, wages and salaries, materials and fuel used, and the amount, value and method of disposal of output.

For the student who is not already intimately acquainted with the statistics in this field, a useful feature is the introductory material describing the sources of the information given, presenting maps of the boundaries of the regional and divisional organizations of the various authorities and setting out the definitions of the principal statistics.

(2) OTHER STATISTICS.

In the second post-war edition of that well-known *vade mecum* on regional economic information, *Marketing Survey of the United Kingdom*. (Editor, Cecil Chisholm. London: Business Publications Ltd., 1951. 5 gns.), a number of changes have been made but the general pattern has remained the same. A new Index on Income Levels has been introduced, which estimates the proportion of households where the main wage earner received a basic wage of £7 10s. per week or more; it is considered that these are the households with surplus income to spend. The figures were based on sampling surveys of 28 towns and extended by a "configuration analysis" on three factors (infant mortality, rateable value and illegitimacy rates) to 142 towns in Great Britain. In the absence of regional income tax statistics in sufficient detail (one of the most conspicuous gaps in British official statistics) this method seems to be quite acceptable. The classification of families by social class for a large number of towns, which however hazardous, was a valuable feature of pre-war editions, has not yet been reintroduced. An interesting new item is the number on waiting lists for houses in each town, but users should beware of the possibility of duplication in these figures. Special articles refer to changes in the 12 largest "conurbations" and the Development Areas and to radio listening. Considering the large number of advertisements in this volume its price can hardly be called modest.

The second issue of the *United Nations' Statistical Year-book*, dated 1949-50, has recently appeared and shows several improvements. Practically all of the tables which in the first issue ended with 1947 have been advanced by two years and now cover the period 1930-1949 (or in some cases 1930-31 to 1949-50), the lack of information on sources for the series in some of the tables to which attention was called in the review of the first issue (see this *Journal*, Vol. CXIII, Part III, 1950) has been largely remedied and a subject index added. A few minor tables have been omitted but several new ones, chiefly in the transport section, have been added and others expanded and improved.

In the second issue of the *United Nations' Demographic Year-book*, also just issued, it has been necessary on the other hand, owing to the large amount of data available, to select certain

subjects as basic, and to treat others at intervals of about five years. In the present issue marriage and fertility statistics are selected. In the population section, a special chapter is devoted to an analysis by regions (of the world) of total population and birth and death rates, in which the reliability of the statistics is appraised. An index of countries is given but no subject index. In view of the system of rotation of subjects now adopted an index covering both the current issue and previous issues will become essential.

In the series "History of the Second World War" the Central Statistical Office has compiled a *Statistical Digest of the War*. Its object is "to bring together the salient facts of the British war effort so far as they are capable of statistical measurement". The Digest covers the years 1939 to 1945 and follows in many respects the tables given in the Annual Abstract of Statistics. It includes, however, tables on many additional subjects such as statistics of the armed forces and auxiliary services, of lend-lease deliveries and finance, of losses of food and raw materials, e.g., through enemy action, naval vessels built, and production of munitions, on which information in this form has not hitherto been available. At the end is a Definitions Section of about 30 pp. which explains the scope and meaning of the figures and provides means "for interpreting the figures without reference to the basic sources". This volume is a valuable record, indispensable to all students of the war of 1939-45.

CURRENT NOTE

The trustees of the Houblon-Norman Fund, on the recommendation of the Advisory Committee, have made the following awards for 1951/52:

Fellowships.—Miss M. L. Brown, Research Student, London University (renewal), "English Commercial Relations in the 1830's"; E. T. Nevin, Research Student, Cambridge (renewal), "The Mechanism of Cheap Money since 1932".

Research Grants.—Miss A. G. Donnithorne, Research Assistant, University College, London, "The Part played by Western Commercial Enterprise in the Development of Malaya and Indonesia"; A. N. Harrison, Bank Official, "History of Banks, Bankers and Banking in Essex"; R. F. Henderson, Fellow of Corpus Christi College, Cambridge, "Sources and Uses of Funds of Public Companies, 1946-50"; P. K. Marks, Bank Official, "The Bank Employee since 1914"; L. S. Pressnell, Assistant Lecturer, University College, Exeter (renewal), "Country Banking, 1780-1845"; J. Saville, Lecturer, University College of Hull, "The Capital Market in England 1850-75, with Special Reference to the Financing of Industry"; A. J. Taylor, Lecturer, University College, London, "The Organization of the British Coal Industry, 1800-1875"; J. A. P. Treasure, Research Student, University of Cambridge (renewal), "British Export Trade, 1939-49"; B. Walkden, Head of the Department of Commerce, Mining and Technical College, Barnsley (renewal), "Uniform Cost Accounting in Relation to Price Control"; A. C. L. Day, Lecturer, London School of Economics, and J. S. G. Wilson, Reader, London School of Economics, "The Development of French Financial Institutions with Special Reference to the Period Post-1939".

An offer of awards for 1952-53 will be made early in 1952. Further information may be obtained from the Secretary, Houblon-Norman Fund, c/o Bank of England, London, E.C.2.

1951]

OBITUARY

SIR GEORGE EPPS, K.B.E., C.B.

Sir George Epps, who died on February 8th, 1951, was a distinguished member of the actuarial profession. Educated at Highgate School and Emmanuel College, Cambridge, he first entered employment, in 1908, in a life office. He was one of the select band of actuaries gathered together in 1912 by the late Sir (then Mr.) Alfred Watson, who had been appointed Chief Actuary to the National Health Insurance Joint Committee, the co-ordinating body set up following the passage into law of the National Insurance Act of 1911. Shortly afterwards, Epps was appointed secretary to the Actuarial Advisory Committee, and from this close and early association with National Health Insurance became a leading authority on the finances of the scheme. He was, in particular, secretary to the Departmental Committee on Approved Society Finance and Administration, of which Sir George Ryan was Chairman. Their recommendations formed the basis of the important changes made in the scheme of National Health Insurance, which were embodied in the National Health Insurance Act of 1918. His deep knowledge of health insurance made him Watson's right-hand man in everything connected with the working of the scheme. Epps succeeded Alfred Henry as Deputy Government Actuary on the latter's sudden death in 1926, and was appointed to the high office of Government Actuary on the death of Sir Alfred Watson in 1936; this post he held until 1944, when he was compelled by ill-health to retire.

During his service in the Government Actuary's Department Epps served on a number of important official committees, notably the Interdepartmental Committee on Social Insurance and Allied Services, better known as the Beveridge Committee. He was prominent at the Institute of Actuaries, serving on the Council of the Institute, and being elected as Honorary Secretary (1928-30), and as Vice-President (1930-32). He was elected a Fellow of the Royal Statistical Society in 1936, serving on the Council from 1937 to 1939, and from 1940 to 1944. He was a Vice-President of the Society from 1941 to 1943. His services to the state were acknowledged by the conferment of the C.B.E. in 1926, of the C.B. in 1931, and of the K.B.E. in 1942, when he was Government Actuary.

Epps's capacity as an actuary was unquestioned, supported as it was by an amazing quickness, and an ability at times to perceive the right conclusion without the interposition of the processes in the chain of reasoning which less gifted colleagues found to be essential to an understanding of the problem in hand. His quite unaffected brilliance was always concealed by a pleasant smile and a modest diffidence which could lead the casual observer to under-rate his ability. Perhaps the highest tribute to his quality as an actuary was the importance attached to his opinions on actuarial and financial matters by his great chief. But it is not because of his professional abilities, considerable though they were, that his memory will live among those who were privileged to know and work with him. A kindly and retiring man, he was temperamentally disinclined to be assertive, and at times this trait put him at a disadvantage, but this disability, if it be one, flowed from a fundamental friendliness towards, and a general liking for, people. It is difficult to recall an unkind utterance from him about anyone. He was the personification of charitableness for the failings of human nature; his whole attitude towards people was to try to help everybody—including even the misguided and the annoying—without fuss and as unobtrusively as possible. A kindly, though always diffident, word of praise to a junior doing his first important job; a little, unexpected present to a colleague, especially a junior; a word of sympathy to somebody who had had a difficult time; a delightful sense of humour—all these represent to his contemporaries the real Epps. Quite simply, Epps generated affection among all those who had the good fortune to know him.

F. A. A. M.

6 = (200)
5x5y

STATISTICAL AND ECONOMIC ARTICLES IN RECENT PERIODICALS

UNITED KINGDOM—

Accounting Research—

April 1951—Theory of foreign branch accounts: *W. T. Baxter* and *B. S. Yamey*. A note on reserves, provisions and profits: *H. C. Edey*. A slaver's accounts: *B. B. Parkinson*. The measurement of productive efficiency—preliminary report: A Sub-Committee of the Incorporated Accountants' Research Committee. The impact of indirect taxes on costs: *R. W. Moon*.

Advancement of Science—

June 1951—The world's food supplies: *K. G. Fenelon*.

Annals of Eugenics—

March 1951—Linkage data from a family of renal glycosurics: *J. C. Houston*. World frequencies of the *O*, *A* and *B* blood-group genes: *N. McArthur* and *L. S. Penrose*. Birth weight, gestation time and survival in sibs: *M. N. Karn*, *H. Lang-Brown*, *H. MacKenzie* and *L. S. Penrose*. The genetical structure of populations: *Sewell Wright*. A comparative quantitative study of the finger-prints of mongolian imbeciles and normal individuals: *S. B. Holt*.

Bankers' Magazine—

May 1951—Balance of payments, 1950-51: *J. Huntsworth*.

Biometrika—

June 1951—Major Greenwood: *P. L. McKinlay*. Tables of the 5 per cent. and 0.5 per cent. points of Pearson curves (with argument β_1 and β_2) expressed in standard measure: *E. S. Pearson* and *M. Merrington*. Regression, structure and functional relationship, Part I: *M. G. Kendall*. Partial and multiple rank correlation: *P. A. P. Moran*. An application of the distribution of the ranking concordance coefficient: *A. Stuart*. The effect of non-normality on the power function of the *F*-test in the analysis of variance: *F. N. David* and *N. L. Johnson*. Efficiency of the method of moments and the Gram-Charlier type A distribution: *L. R. Shenton*. On distributions for which the Hartley-Khamis solution of the moment-problem is exact: *H. P. Mulholland*. Estimation problems when a simple type of heterogeneity is present in the sample: *W. M. Long*. Some tests for randomness in plant populations: *M. Thomas*. Charts of the power function for analysis of variance tests, derived from the non-central *F*-distribution: *E. S. Pearson* and *H. O. Hartley*. Some questions of distribution in the theory of rank correlation: *S. T. David*, *M. G. Kendall* and *A. Stuart*. Note on an exact treatment of contingency, goodness of fit and other problems of significance: *G. H. Freeman* and *J. H. Halton*. The geometry of estimation: *J. Durbin* and *M. G. Kendall*. Testing for serial correlation in least squares regression. II: *J. Durbin* and *G. S. Watson*. Bi-variate *k*-statistics and cumulants of their joint sampling distribution: *M. B. Cook*. Random dispersal in theoretical populations: *J. G. Skellam*. The frequency distribution of the product-moment correlation coefficient in random samples of any size drawn from non-normal universes: *A. K. Gayen*. Some observations on the practical aspects of weighing designs: *K. S. Banerjee*. Test for the significance of the difference between means in two normal populations having unequal variances: *D. G. C. Gronow*.

British Journal of Social Medicine—

January 1951—A study of weight gain in the first year of life: *J. Parfit*. Spread of tuberculosis from house to house: *J. Webb* and *A. Stewart*. Risk of stillbirth in twin pregnancy related to sex and maternal age: *C. R. Lowe* and *R. G. Record*. Statistical utilization of maternity and child welfare records: *E. Charles*.

1951]

April 1951—Pulmonary tuberculosis mortality in the printing and shoe-making trades. Historical survey, 1881–1931: *M. Cairns* and *M. Stewart*. Incidence of mongolism and its diagnosis in the newborn: *C. Carter* and *D. MacCarthy*. A note on secular changes in the human sex ratio at birth: *C. R. Lowe* and *T. McKeown*. Observations on all births (23,970) in Birmingham, 1947. II: *T. McKeown* and *J. R. Gibson*. Birth weights of South African babies: *E. J. Salber* and *E. S. Bradshaw*.

Economica—

May 1951—Imperfect competition in retail trades: *J. Hood* and *B. S. Yamey*. A regional analysis of British import prices: *K. L. Kinsman*. Great Britain's capital formation, 1865–1914: *J. H. Lenfant*. Changes in the structure of the German banking system: *J. Lanner*. The removal of trader barriers: the regional *versus* the universal approach: *J. E. Meade*.

Incorporated Statistician—

Vol. 2, No. 1—Productivity statistics for management: *L. H. C. Tippett*. Statistics for market research: *M. Abrams*. Organization of statistical departments: some details of market research by the North Thames Gas Board: *J. A. Reece*. Report of the second Annual General Meeting of the Association of Incorporated Statisticians.

Institute of Actuaries, Journal—

Vol. LXXVII, Part I, No. 345—The actuary in the national economy. Address by the President, *F. A. A. Menzler*. The papers of the Royal Commission on Population: *F. M. Redington* and *R. D. Clarke*. The recent trend of mortality in England and Wales: *W. S. Hocking*.

Lloyds Bank Review—

July 1951—Guns, butter, and cows: *J. Davenport* and *K. Bloch*. The Colombo plan for economic development: *V. K. R. V. Rao*. Local finance: *D. N. Chester*.

Manchester School of Economic and Social Studies—

May 1951—Utility and all that: *D. H. Robertson*. Economic opinion in England as Jevons found it: *S. G. Checkland*. The case for rationalization of the building industry: *K. Bowen*. The economic development of the Highlands: *T. A. F. Noble*.

Oxford University Institute of Statistics Bulletin—

April 1951—Exchange rates and national income: *T. Balogh* and *P. P. Streeten*. Differences between the wages of skilled and unskilled workers, 1880–1950: *K. G. J. C. Knowles* and *D. J. Robertson*. Family expenditure in 1949. Part I: *T. Schulz*.

May 1951—Family expenditure in 1949. Part II: *T. Schulz*. Rearmament and the U.S. balance of payments: *T. Balogh*. Inventory gains and the national income: *P. D. Henderson*.

June 1951—A “human needs” diet in April 1951: *T. Schulz*. Earnings in engineering, 1926–1948: *K. G. J. C. Knowles* and *D. J. Robertson*.

Review of Economic Studies—

Vol. XVIII (I), No. 45—The economic aspects of advertising: *N. Kaldor*. Devaluation and the terms of trade: *C. Kennedy*. A reconsideration of the general equilibrium theory of money: *D. Patinkin*. A note on long-run unemployment: *M. Kalecki*. A note on “A constant-utility index of the cost of living”: *R. C. Geary*.

Three Banks Review—

June 1951—Some features of international trade in 1950: *E. Devons*. Sulphur: *C. E. Young*.

INDIA—

Calcutta Statistical Institute Bulletin—

April 1951—Indian Science Congress—thirty-eighth Session. On analysis of variance test: *H. K. Nandi*. Partially balanced incomplete block designs: *R. C. Bose*. On an estimate of the location parameter of a symmetrical population: *C. S. Pillai*.

UNION OF SOUTH AFRICA—

South African Journal of Economics—

March 1951—Gold and the return to the ideas of John Law: *C. Rist*. The price of gold and its place in monetary theory: *P. F. D. Wallis*. Keynesian views on the price of gold: *W. J. Busschau*. Variable costing: an aid to management (Part I): *Z. S. Gurzynski*.

UNITED STATES—

American Academy of Political and Social Science, Annals—

March 1951—Labor in the American economy (whole number).

May 1951—Civil rights in America (whole number).

American Economic Review—

March 1951—A program for economic mobilization: *E. S. Shaw* and *L. Tarshis*. General strategy of economic policy: *A. G. Hart*. Credit control in France: *M. A. Kriz*. On the measurement of income inequality: *R. R. Schutz*. The distorting effects of direct taxation: *E. Schwartz* and *D. A. Moore*. The over-investment theory of the cycle: *G. A. Bishop*.

May 1951—Papers and Proceedings of the sixty-third Annual Meeting of the American Economic Association, December 27–30, 1950.

American Statistical Association, Journal—

March 1951—Undergraduate statistical education: *S. S. Wilks*. The influence of *Statistical Methods for Research Workers* on the development of the science of statistics: *F. Yates*. The impact of R. A. Fisher on statistics: *H. Hotelling*. The Fisherian revolution in methods of experimentation: *W. J. Youden*. R. A. Fisher's *Statistical Methods for Research Workers*: *K. Mather*. The theory of statistical decision: *L. J. Savage*. The Kolmogorov-Smirnov test for goodness of fit: *F. J. Massey, Jr.* A large sample *t*-statistic which is insensitive to non-randomness: *J. E. Walsh*. A short-cut measure of correlation: *W. A. Spur*. On stratification and optimum allocations: *W. D. Evans*. Sampling with probabilities proportional to size: *N. Keyfitz*. A source of bias in one of the samples of the 1950 Census: *P. O. Steiner*. The distribution of blocks in an uncongested stream of automobile traffic: *M. S. Raff*. Willard Phillips, a predecessor of Paasche in index number formulation: *R. W. Jastram*.

American Statistician—

February 1951—Statistical literacy in the social sciences: *H. M. Walker*. The development of statistical quality control in the United States, Part II: *S. B. Littauer*.

Annals of Mathematical Statistics—

March 1951—Elimination of randomization in certain statistical decision procedures and zero-sum two-person games: *A. Dvoretzky*, *A. Wald* and *J. Wolfowitz*. On minimax statistical decision procedures and their admissibility: *C. R. Blyth*. On minimum variance in non-regular estimation: *C. R. Davis*. On the distribution of Wald's classification: *H. L. Harter*. Ratios involving extreme values: *W. J. Dixon*. On information and sufficiency: *S. Kullback* and *R. A. Leibler*. On the fundamental lemma of Neyman and Pearson: *G. B. Dantzig* and *A. Wald*. Estimators of the probability of the zero class in Poisson and certain related populations: *N. L. Johnson*. Testing proportionality of covariance matrices: *W. Federer*. An inverse matrix adjustment arising in discriminant analysis: *M. S. Bartlett*. On a theorem of Lyapunov: *D. Blackwell*. A note on the test of serial correlation coefficients: *M. Ogawara*. Remark on separable spaces of probability measures: *A. Berger*. Table of the asymptotic distribution of the second extreme: *E. J. Gumbel* and *J. A. Greenwood*. The distribution of the maximum deviation between two sample cumulative step functions: *F. A. Massey, Jr.* A note on the surprise index: *R. M. Redheffer*. Approximation to the point binomial: *B. H. Camp*. A theorem on the correlation coefficient for samples of three when the variables are independent: *C. C. Sekar*. Correction to "The distribution of extreme values in samples whose members are subject to a Markoff chain condition": *B. Epstein*.

1951]

Biometrics—

March 1951—The present status of variance component analysis: *S. Lee Crump*. Testing a linear relation among variances: *W. G. Cochran*. Components in regression: *J. W. Tukey*. Analysis of variance with unequal but proportionate numbers of observations in the sub-classes of a two-way classification: *H. Fairfield Smith*. Consistency of estimates of variance components: *R. E. Comstock* and *H. F. Robinson*. Use of components of variance in preparing schedules for the sampling of baled wool: *J. M. Cameron*. Variance components as a tool for the analysis of sample data: *W. A. Hendricks*. Estimating precision of textile instruments: *J. C. Whitwell*.

Econometrica—

April 1951—The rate of interest: *J. Robinson*. Le "revenu distribuable" et les pertes économiques: *M. Boiteux*. The invalidity of classical monetary theory: *D. Patinkin*. Inconsistency and indeterminacy in classical economics: *K. Brunner*. The application of Pareto's law of income to Japanese data: *M. Hayakawa*. Two consequences of the transposition theorem on linear inequalities: *T. S. Motzkin*. A note on Motzkin's transposition theorem: *M. L. Slater*.

Estadística—

March 1951—Use of crop-weather relationships in forecasting crop yields: *J. C. Scholl*. The use and development of balance of payment statistics: International Monetary Fund. The construction of the first Venezuelan life tables, 1941-1942: *E. Michalup*.

Harvard Business Review—

March 1951—Major economic problems of mobilization: *S. E. Harris*. Evaluation of forward buying: *H. T. Lewis*. A tool for management control: *J. R. Curley*. The Schuman Plan: *J. Chastenet*. Efficiency and profitability in relation to size: *R. C. Osborn*. Accelerating aircraft production during World War II: *D. W. Ewing*. Use of opinion research: *L. Bogart*.

Industrial Quality Control—

March 1951—Additional continuous sampling inspection plans: *H. F. Dodge* and *M. N. Törey*. Some legal aspects of sampling: *F. R. Kennedy*. Determining conformance with requirements for lot averages: *D. H. Schwartz* and *P. Kaufman*. Quality control at Talon, incorporated: *J. S. Zahnheiser* and *D. Lehman*. Effect of sample size on estimating population per cent. defective from samples: *I. B. Altman*.

May 1951—Management's obligation in quality control: *D. P. Cady*. A technique for adjusting sales predictions to actual sales trends: a method of inventory control: *F. B. Newman*. Quality control in manufacture—some considerations for management: *A. G. Dalton*. Some aspects of quality control as applied to clerical operations: *B. B. Murdock*. The quality problem on purchased material: *C. J. Hawkes*. Installing a complete quality control system: *S. C. Amren*. Some statistical principles of tolerances: *G. M. Hailes*. Statistical quality control in the foundry: *G. Ver Beke*.

Journal of Political Economy—

April 1951—United States merchant marine policy and surplus ships: *J. G. B. Hutchins*. Advertising, product variation, and the limits of economics: *A. Sherrard*. Wage determination and involuntary unemployment: *A. Rees*. The wealth-saving relationship: *G. Ackley*.

Mathematical Tables and other Aids to Computation—

April 1951—The California digital computer: *P. M. Morton*. Step-by-step integration of $\ddot{x} = f(x, y, z, t)$ without a "corrector": *S. Herrick*. Formulas for calculating the error function of a complex variable: *H. E. Salzer*.

Milbank Memorial Fund Quarterly—

April 1951—Health service organization in Western Europe: *M. I. Roemer*. Nutritional status of selected population groups in Oregon. 1. Food habits of native born and reared school children in two regions: *C. A. Storvick*, *B. Schaad*, *R. E. Coffey* and *M. B. Deardorff*. The control of acute respiratory illness by ultra-violet light. Study No. 2: *J. Downes*.

Social and psychological factors affecting fertility. XII. The relationship of general planning to fertility planning and fertility rates: *R. Freedman and P. K. Whelpton.*

Psychometrika—

March 1951—Remarks on the method of paired comparisons: I. The least squares solution assuming equal standard deviations and equal correlations: *F. Mostellar.* The dimensions of temperament: *L. L. Thurstone.* A note on correcting for chance success in objective tests: *S. B. Lyerly.* Classification by multivariate analysis: *T. W. Anderson.*

Quarterly Journal of Economics—

May 1951—Review of the troops (a chapter from the history of economic analysis): *J. A. Schumpeter.* Distance inputs and the space-economy. Part I: the conceptual framework: *W. Isard.* Long-range cost estimates for old-age insurance: *C. C. Killingsworth* and *G. Schroeder.* Oil refining: cross-elasticities of supply: *A. Manne.* Union wage policy and the supply of labor: *L. Ulman.* On the theory of price agreements: *H. Brems.*

Review of Economics and Statistics—

February 1951—Meaning and measurement of “full” or “maximum” employment: *T. K. Hitch.* Contribution of manufacturing wages to regional differences in *per capita* income: *F. A. Hanna.*

Society of Actuaries, Transactions—

Vol. II, Part 3, No. 4—New Zealand social insurance system: *R. J. Myers.* On the large sample distribution of mortality rates based on statistically independent lives: *J. E. Walsh.* Projections—how to make them and how to use them: *A. M. Niessen.*

BRAZIL—

Revista Brasileira de Estatística—

April-June 1951—Sobre um problema de ajustamento analítico: *R. Nogueira.* O problema dos números-índice: *R. Frisch.* A fecundidade masculina, na população do Brasil, segundo a idade, a atividade principal e a posição na ocupação: *G. Mortara.* Propriedades extremas dos valores típicos, nos conjuntos finitos de observações: .

EGYPT—

L'Egypte Contemporaine—

November-December 1950—A study of the national income of Egypt: *M. A. Anis* (whole number).

FRANCE—

Journal de la Société de Statistique de Paris—

January-March 1951—Utilisation de la taxe à la production pour la statistique: *J. Corréard.* Les variations concomitantes de l'énergie consommée et du produit national: *J. Prévot.* Les sondages d'opinion et l'échec des prévisions électorales de Gallup en 1948: *R. Lévy-Bruhl.* Sur la composition des gisements minéraux: *F. Blondel.*

Population—

January-March 1951—L'oeuvre de l'Organisation Internationale pour les Réfugiés: *P. Jacobsen.* Nouvelles données sur la mortalité d'origine alcoolique: *S. Ledermann* and *F. Tabah.* Effets des mariages consanguins sur la descendance: *J. Sutter* and *L. Tabah.* Prédominance du mari ou de la femme dans le ménage. Une enquête sur la vie familiale: *P. Fougeyrollas.* Mobilité sociale et dimension de la famille. Deuxième partie: Enquête dans les lycées et les facultés: *A. Girard.*

GERMANY—

Mitteilungsblatt für Mathematische Statistik—

Vol. 3, Part 1—Elektronik und Statistik: *A. Adam, O. P. Fuchs* and *H. Kottas.* Zur Korrelationstheorie zweidimensionaler Merkmale: *W. Krull.* Eine Reliefdarstellung der Fisherschen F-Verteilung: *U. Graf* and *H. J. Henning.* Über einige nichtparametrische

1951]

Testverfahren: *E. Walter*. Anwendung gleitender Durchschnitte zur Herausarbeitung von Trendlinien und Häufigkeitsverteilungen: *H. Gebelein*. Bemerkungen zur Anwendung statistischer Methoden in der Technik (Berichtigungen): *E. Rossow*.

Weltwirtschaftliches Archiv—

Vol. 66, Part I (1951)—Optimum allocation in econometrics and physics: *A. Pikler*.

HOLLAND—

Statistica—

Vol. 4, No. 6—Enkele historische betrekkingen tussen mathematische en verzamelende statistiek: *D. van Dantzig*. De gereduceerde χ^2 methode: *J. Hemelrijk*. De wiskundige behandeling van het onderscheidingsvermogen van een steekproefschema: *G. Quintelier*.

ITALY—

Statistica—

January–March 1951—Caractères des plus récents développements de la méthodologie statistique: *C. Gini*. Ricerca antropologica e demografica su un gruppo di ebrei milanesi: *G. B. Ghidoli*.

JAPAN—

Institute of Statistical Mathematics, Annals—

Vol. II, No. 2—Sampling design in the Social Survey of Language at the city of Shirakawa: *C. Hayashi*. On some criteria for stratification: *C. Hayashi, F. Maruyama, and M. D. Ishida*. Note on a solution of the generalized Behrens-Fisher problem: *B. M. Bennett*. "r" distributions and "r" tests: *R. Sato*.

SWITZERLAND—

Schweizerische Zeitschrift für Volkswirtschaft und Statistik—

April 1951—Die Frage der staatlichen Intervention in der Uhrenindustrie: *H. Böhi*. Die Ausgestaltung des Unternehmensbesteuerung zu einem Mittel der Konjunkturpolitik: *R. Borkowsky*. Random sampling in measurement of net national product: *S. Zagoroff*. Die betriebswirtschaftliche Funktion des Wagnisses: *K. F. Bussmann*.

INTERNATIONAL—

International Labour Review—

March 1951—The stabilization of dockworkers' earnings: *A. A. P. Dawson*.

April 1951—The stabilization of dockworkers' earnings. II: *A. A. P. Dawson*.

Revue de l'Institut International de Statistique—

Vol. 18, No. 3/4—Sur un essai infondé de sauver le coefficient classique dit de corrélation: *M. Fréchet*. Etude statistique sur les propriétés des fontes: *P. Delaporte*. Some notes on lot-by-lot inspection by attributes: *H. C. Hamaker*. Class differentials in expectation of life at birth: *A. J. Mayer and Ph. M. Hauser*.

LIST OF ADDITIONS TO THE LIBRARY

Since the issue of Part II, 1951, the Society has received the publications enumerated below.

I.—OFFICIAL PUBLICATIONS

(a) United Kingdom

Agriculture and Fisheries, Ministry of

National farm survey of England and Wales (1941–1943): a summary report. London, H.M.S.O., 1946. vi, 109 pp. 9½". 2s.

Report of the committee appointed to review the organisation of the Ministry of Agriculture and Fisheries. London, H.M.S.O., 1951. ii, 57 pp. 9½". 1s. 9d.

Central Statistical Office. Statistical digest of the war: prepared in the Central Statistical Office. London, H.M.S.O., 1951. xii, 248 pp. 9½ × 8½". 32s. 6d.

Colonial Development Corporation. Annual report and statement of accounts for the year ended 31st December, 1950 ... London, H.M.S.O., 1951. vi, 63 pp. 9½". 2s.

Colonial Office

British islands in the Southern Hemisphere 1945–1951 ... London, H.M.S.O., 1951. Cmd 8230. vi, 12 pp. 9½". 3s. 6d.

The Colonial territories (1950–51) ... London, H.M.S.O., 1951. Cmd. 8243. ix, 184 pp. 4s. 6d.

Development and welfare in the West Indies: report by the Comptroller for the year 1950. London, H.M.S.O., 1951. 114 pp. 9½". 4s. 6d. (Colonial 269.)

First conference of colonial government statisticians, 1950. Report. London, H.M.S.O., 1951. 16 pp. 9½". 9d. (Colonial 267.)

Education, Ministry of

Ready reckoner of food values: protein, fat and calorie values of foods by standard quantities for the use of caterers. London, H.M.S.O., 1951. 59 pp. 9½". 2s.

Training and supply of teachers. First report of the National Advisory Council covering the period July, 1949, to February, 1951. London, H.M.S.O., 1951. 24 pp. 9½". 1s.

Forestry Commission. Census of woodlands 1947–1949. Summary report. London, H.M.S.O., 1951. 15 pp. 8". 6d. (Forest Record no. 3.)

Local Government and Planning, Ministry of. Town and country planning 1943–1951: progress report by the Minister of Local Government and Planning on the work of the Ministry ... London, H.M.S.O., 1951. Cmd. 8204. vii, 215 pp. 9½". 5s.

Medical Research Council

The application of scientific methods to industrial and service medicine (proceedings of a conference held from March 29th to March 31st, 1950). London, H.M.S.O., 1951. 112 pp. 9½". 3s.

Royal Commission on Betting, Lotteries and Gaming 1949–1951. Report. London, H.M.S.O., 1951. Cmd. 8190. vi, 190 pp. 9½". 4s. 6d.

Scottish Home Department. Industry and employment in Scotland 1950. Edinburgh, H.M.S.O., 1951. Cmd. 8223. 88 pp. 9½". 2s. 6d.

Social Survey

Consumer expenditure series. Betting in Britain; by W. F. F. Kemsley and David Ginsburg: a report on betting habits and spending in 1949/50 prepared for the Central Statistical Office in consultation with the Royal Commission on Betting, Lotteries and Gaming. London, C.O.I., [1951]. 32 pp. 13".

1951]

Domestic utilization of heating appliances and expenditures on fuels in 1948/49; by Leslie T. Wilkins. Data from various sources are combined to provide estimates of the possession of fuel appliances and of expenditure on coal, gas and electricity in 1948/49 ... London C.O.I., 1951. 56 pp. 13".

Recruitment to the civil defence services; by J. E. Fothergill and D. L. Lamberth: a report of an inquiry made in March-April 1950 at the request of the Home Office and the Scottish Office. London, C.O.I., 1950. iv, 65 pp. 13".

Treasury. Report of the committee on the taxation of trading profits. London, H.M.S.O., 1951. Cmd. 8189. 132 pp. 9½". 3s. 6d.

Trade, Board of. Commercial Relations and Exports Department. Overseas economic surveys: Costa Rica, July 1950. iv, 28 pp., map. 1s. 3d. Panama, September, 1950. iv, 46 pp., map. 1s. 9d. Turkey, April, 1950. x, 192 pp., map. 4s. 6d. London, H.M.S.O., 1951. 9½".

(b) Other National and International Publications

Australia

Bureau of Census and Statistics.

Census of the Commonwealth of Australia, 30th June, 1933. Vol. III, Comprising parts xxvii to xxix of the detailed tables, Statistician's report, and Australian life table. Canberra, 1939. Various paging, maps. 12½".

Census of the Commonwealth of Australia, 30th June, 1947, parts i-vii, Analysis of population in local government areas. Canberra, 1949-50. 7 vols. 13". 2s. 6d. each part. —Part viii.—Population and occupied dwellings in localities. Part ix.—Age. Part x.—Conjugal condition. Part xi.—Dependent children. Canberra, 1949-50. 4 vols. 13". 2s. 6d. each part.

India

Department of Economic Affairs. First report of the National Income Committee, April, 1951. New Delhi, 1951. [3] 102 pp. 9½".

New Zealand

Census and Statistics Department. Population census, 1945. Vol. IX.—Industries and occupations. Wellington, n.d. vii, 108 pp. 12¼". 7s. 6d.

Norway

Statistisk Sentralbyrå. Jordbruksstillingen i Norge, 20 juni, 1949. Først hefte. Arealet, husdyrholdet m.v. herredsvise oppgaver. Oslo, 1950. 419 pp. 9½". kr. 4. (N.O.S., xi, 40.)

Switzerland

Bureau Fédéral de Statistique

Bevölkerungsbewegung in der Schweiz ... 1945-1948. Text, 107 pp. Tabellen, 304 pp. Bern, 1950-51. 2 vols. 11½".

Recensement fédéral de la population, 1er décembre 1950. Population résidente des communes. Résultats non contrôlés. Bern, 1951. [4] 52 pp. 8½".

Union of South Africa

Bureau of Census and Statistics. Eighth census of the population of the Union of South Africa, 7th May, 1946. Volume III. South African Life tables, Nos. E.4 (Europeans) and C.2. (Mixed and other coloured). Pretoria, 1951. xxiv, 14 pp. 12¼". 5s.

United States of America

Bureau of the Census. Handbook of statistical methods for demographers: selected problems in the analysis of census data; by A. J. Jaffe ... Preliminary edition ... Washington, Govt. Printing Office, 1951. viii, 278 pp. 11¼".

II.—AUTHORS AND MISCELLANEOUS

- ABRAMS (MARK). Social surveys and social action. London, Heinemann, 1951. [4], 153 pp. 7 $\frac{1}{4}$ ". 8s. 6d.
- ANDERSON (R. L.) and MANNING (H. L.). An experimental design used to estimate the optimum planting date for cotton. *Biometrics*, (1948). 4, 171-196. 9 $\frac{1}{4}$ ".
- ANDERSON (W. A.). Marriages and families of university graduates. Ithaca, N.Y., Cornell Univ. Press, 1950 (London, Oxford Univ. Press). xi, 52 pp. 9". 8s.
- ARROW (KENNETH J.). Social choice and individual values. New York, John Wiley, 1951 (London, Chapman & Hall). xi, 99 pp. 9". 20s. (Cowles Commission for Research in Economics monograph, 12.)
- ASHBY (A. W.). Development and situation of research in agricultural economics in Great Britain, 1950 (Tirage à part de la publication jubilaire éditée à l'occasion du 80^e anniversaire de M. le professeur E. Laur.) pp. 63-78. 9".
- BERTOLINO (ALBERTO). Esplorazioni nella storia del pensiero economico. Florence, La Nuova Italia, 1950. xi, 417 pp. 8 $\frac{1}{2}$ ".
- BLAGBURN (C. H.). Costs and returns from barley production on 28 farms in the south of England in 1949. University of Reading Dept. of Agric. Economics, 1950. 10 pp. 10". 2s. (Miscellaneous cost studies, 17.)
- BRANDT (KARL). The world economic situation of fats and oils. *J. Amer. Oil Chem. Soc.*, (1950), 27, 401-408. 11 $\frac{1}{4}$ ".
- BRAY (F. SEWELL). The accounting mission. Melbourne, published for the Commonwealth Institute of Accountants by Melbourne Univ. Press, 1951. (London, Cambridge Univ. Press.) vi, 89 pp. 8 $\frac{1}{2}$ ". 15s.
- BRITISH SHAREHOLDERS TRUST LTD. A composite chart of share and commodity indices from 1866-1949. London, B.S.T. Ltd., 1950. 1 chart (23" × 12").
- BROSS (IRWIN). Fiducial intervals for variance components. *Biometrics* (1950), 6, 136-144. 9 $\frac{1}{4}$ ".
- CAMBRIDGE UNIVERSITY. DEPARTMENT OF APPLIED ECONOMICS. Reprint series, 37. A further statistical note on the distribution of individual output; by A. D. Roy. *Econ. J.* (1950), 60, 831-836. 9 $\frac{1}{2}$ ".
- 38. The form of government accounts, I; by A. A. Garrett. The form of government accounts, II; by W. B. Reddaway. *Accounting Res.* (1951). 2, 52-76. 9 $\frac{3}{4}$ ".
- 39. Movements in the real product of the United Kingdom, 1946-1949; by W. B. Reddaway. *J. R. Statist. Soc.*, (1950). 113 A, 435-463. 9 $\frac{1}{2}$ ".
- 40. Electricity tariffs in theory and practice; by H. S. Houthakker. *Econ. J.* (1951), 61, 1-25. 9 $\frac{1}{2}$ ".
- 41. A test for linear relations between weighted regression coefficients; by Gerhard Tintner. *J. R. Statist. Soc. B.* (1950). 12, 273-277. 9 $\frac{1}{2}$ ".
- 42. Prediction from autoregressive schemes and linear stochastic difference systems; by Richard Stone. *Proc. Int. Statist. Conf.* (1947). 5, 38 pp. 9".
- CHESTER (D. N.). The nationalized industries: an analysis of the statutory provisions. 2nd ed. London, for the Institute of Public Administration, by Allen & Unwin, 1951. 93 pp. 8 $\frac{1}{2}$ ". 7s. 6d.
- CHINTSCHIN (A. L.). Drei Perlen der Zahlentheorie. Berlin, Akademie-Verlag, 1951. 61 pp. 8 $\frac{1}{4}$ ".
- CLEMENCE (RICHARD V.). Income analysis. Cambridge, Mass., Addison-Wesley Press, 1951. ix, 182 pp. 6 $\frac{3}{4}$ ". \$2.50.
- COCHRAN (WILLIAM G.). Estimation of bacterial densities by means of the "Most probable number." *Biometrics* (1950). 6, 105-116. 9 $\frac{1}{4}$ ".
- COLOMBO (BERNARDO). La recente inversione nella tendenza nella natalità. Padua, Cedam, 1951. viii, 183 pp. 10". 1500 l.
- COMRIE (L. J.). Calculating machines; by L. J. Comrie ... being Appendix III to L. R. Connor's Statistics in theory and practice. London, Pitman, 1938. [23] pp. 8 $\frac{3}{4}$ ".
- CRUMP (NORMAN). The ABC of the foreign exchanges ... 11th ed. London, Macmillan, 1951. viii, 403 pp. 7 $\frac{1}{2}$ ". 12s. 6d.
- DELURY (DANIEL B.). Values and integrals of the orthogonal polynomials up to $n = 26$. Univ. of Toronto Press, 1950. (London, Oxford Univ. Press.) 33 pp. 10". 9s. 6d.
- DIEULEFAIT (ENRIQUE E.). Análisis estadístico de la significación de las diferencias entre dos o mas muestras que provienen de un universo gaussiano. Rosario, Facultad de Ciencias Economicas, Comerciales y Politicas. Instituto de Estadística, 1949. 24 pp. 10 $\frac{1}{4}$ ".
- FISHER (RONALD AYLMER). Creative aspects of natural law ... the Fourth Arthur Stanley Eddington Memorial Lecture, 2nd November 1950. Cambridge University Press, 1950. v, 23 pp. 7". 2s.

1951]

- GEARY (R. C.). The official cost of living index number and its critics. Cork University Press, 1951. (Oxford, B. H. Blackwell.) 30 pp. 8 $\frac{1}{4}$ ". 1s. 6d. (University and labour series, 10.)
- HANSEN (ALVIN H.). Business cycles and national income ... New York, W. W. Norton & Co., 1951. xv, 639 pp. 8 $\frac{1}{2}$ ". 55s.
- HEATH (A. E.), editor. Scientific thought in the twentieth century: an authoritative account of fifty years' progress in science ... London, Watts, 1951. xv, 387 pp. 8 $\frac{1}{2}$ ". 42s.
- HEYWORTH (Sir GEOFFREY). Productivity. London, Lever Bros. and Unilever Ltd., 1950. 18 pp. 8".
- INTER AMERICAN STATISTICAL INSTITUTE. Statistical vocabulary. Washington, D.C., 1950. xviii, 117 pp. 10 $\frac{1}{2}$ ".
- INTERNATIONAL ASSOCIATION FOR RESEARCH IN INCOME AND WEALTH. Income and wealth, I ... edited by Erik Lundberg. Cambridge, Bowes & Bowes, 1951. xv. 297 pp. 9 $\frac{1}{2}$ ". 30s.
- INTERNATIONAL TIN STUDY GROUP. A statement on the position and prospects of the tin industry. 58 pp. 11 $\frac{1}{2}$ ". 7s. 6d.
- Draft international agreement on tin, March, 1950. 22 pp. 11 $\frac{1}{4}$ ". 5s.
- Project d'accord international sur l'étain, March, 1950. 23 pp. 11 $\frac{1}{4}$ ". 275f.
- Tin 1949-1950: a review of the world tin industry, 1951, 55 pp. 10". 4s. The Hague, International Tin Study Group. 4 vols.
- JOHNS (J. R. H.). Metropolitan government in Western Australia. Crawley, Univ. of Western Australia, 1950. iii, 78 pp. 10". 5s. 6d.
- KERR (A. M.). Personal income of Western Australia. Crawley, Univ. of Western Australia, 1951. x, 107 pp. 9 $\frac{1}{2}$ ". 7s. 6d.
- KOOP (J. C.). On a large sample method of estimating unemployment in large cities. *Current Science* (1950). 19, 232-233. 9 $\frac{3}{4}$ ".
- LASORSA (GIOVANNI). *Statistica economica*. 3rd ed. Padua, Cedam, 1950. xv, 493 pp. 10". 3000 l.
- LEHMANN (E. L.) and SCHEFFE (HENRY). Completeness, similar regions, and unbiased estimation—Part I. *Sankhyā* (1950), 10, 305-340. 11 $\frac{1}{4}$ ".
- MADOW (WILLIAM G.). Teoria dos levantamentos por amostragem; lições de William G. Madow ... recolhidas e compiladas por Vasco Pinto de Magalhães ... Lisbon, Instituto Nacional de Estatística, 1950. xv, 280 pp. 9".
- MANLEY (CLAUD VICTOR). A fifty years' survey of casualties to merchant ships reported abandoned, foundered, or missing. *Trans. Inst. Naval Architects* (1950). 15 pp. 11".
- A further examination of casualties to merchant ships reported abandoned, foundered or missing. *Inst. Naval Architects Paper*, 7 (1950). 13 pp. 11". (Presented by the author.)
- Memoirs of the American Mathematical Society, Number 6. Four papers on probability. New York, American Mathematical Society (1951). 47 pp. \$1.50.
- MINTZ (ILSE). Deterioration in the quality of foreign bonds issued in the United States 1920-1930. New York, Nat. Bur. of Economic Research, 1951. xi, 100 pp. 9". \$2. (Publications of the N.B.E.R., 52.)
- MITCHELL (WESLEY C.). What happens during business cycles: a progress report. New York, Nat. Bur. of Economic Research, 1951. xxxi, 386, [6] pp. 9". \$5. (Studies in business cycles, 5.)
- MOREY (LLOYD) and HACKETT (ROBERT PHILLIP). Fundamental accounting; by Lloyd Morey ... and Robert Phillip Hackett ... 2nd ed ... Successor to *Introduction to Governmental Accounting* New York, John Wiley, 1951. (London, Chapman & Hall.) xiii, 518 pp. 9". \$5.50.
- NATIONAL BUREAU OF ECONOMIC RESEARCH. Studies in income and wealth. New York, N.B.E.R., 1951. xiv, 587 pp. 9". \$6.
- PEFFER (E. LOUISE). The closing of the public domain: disposal and reservation policies 1900-50. Stanford Univ. Press, 1951. (London, Oxford Univ. Press.) xi, 372 pp. 9". \$4.50.
- Proceedings of the Auburn conference on statistics applied to research in the social sciences, plant sciences and animal sciences, September 7-9, 1948. Auburn, Statistical Laboratory, Alabama Polytechnic Institute, 1949. xii, 91 pp. 11".
- RHODES (EDGAR) and SMITH (H. FAIRFIELD). The viscosity of preserved and concentrated latex. Part I. Relationship between dry rubber content and viscosity; by E. Rhodes and H. F. Smith. Part II. Viscosity-temperature relationship of latex; by E. Rhodes. *J. Rubber Res. Inst., Malaya*. (1939) 9, 171-199. 9 $\frac{1}{4}$ ".
- RIX (M. S.). Investment arithmetic: a practical guide to the methods of financial calculations. London, Pitman, 1951. x, 155 pp. 8 $\frac{1}{4}$ ". 15s.
- ROBERTSON (F. L.) and THRING (M. W.). A statistical analysis of the open-hearth furnace. *J. Iron Steel Inst* (1949). 164, 31-50. 11".

- RUSHTON (S.) and DAVIES (D. R. G.). The variation in electrical properties of silicon-iron transformer sheet: a statistical analysis of data from a single cast. *J. Iron Steel Inst* (1951). 167, 247-261. 11".
- SALTER (Sir ARTHUR). Foreign investment. Princeton, N.J., Princeton Univ., 1951. 56 pp. 9". (Essays in international finance, 12.)
- Scientific and learned societies of Great Britain: a handbook compiled from official sources. 57th ed. London, Allen & Unwin, 1951. 227 pp. 8½". 30s.
- SEERS (DUDLEY). The levelling of income since 1938. Oxford, Basil Blackwell, 1951. 74 pp. 9½". 5s.
- SELTZER (LAWRENCE H.). The nature and tax treatment of capital gains and losses; H. Seltzer ... with the assistance of Selma F. Goldsmith and M. Slade Kendrick. New York, Nat. Bur. of Economic Research, 1951. xxii, 554 pp. 9". \$7.50. (Fiscal studies, 3).
- SMITH (H. FAIRFIELD). The variability of plant density in fields of wheat and its effect on yield. Melbourne, Council for Scientific and Industrial Research, 1937. 28 pp. 9½". (Bulletin, 109).
- An empirical law describing heterogeneity in the yields of agricultural crops. *J. Agric. Sci.* (1938). 28, 1-23. 10¼".
- Report of a preliminary statistical investigation of flowering dates of plants recorded in the phenological reports of the Royal Meteorological Society. *Quart. J. R. Met. Soc.* (1938). 64, 23-44. 9¾".
- The effect of spacing and time of sowing on yield and yield components of wheat varieties. Melbourne, Council for Scientific and Industrial Research, 1939. 23 pp. 9½". (Pamphlet No. 91.)
- Specific gravity of latex and of rubber. *J. Rubber Res. Inst. Malaya* (1940). 9, 218-247. 9½".
- The viscosity of preserved and concentrated latex; Part III. Relationship of viscosity to temperature and dry-rubber-content. *J. Rubber Res. Inst. Malaya* (1941). 11, 44-58. 9½".
- Use of hydrometers to estimate dry rubber content of latex. *J. Rubber Res. Inst. Malaya* (1947). 12, 47-61. 9½". 50c.
- A sampling survey of tapping on small holdings (1939-40). *J. Rubber Res. Inst. Malaya* (1948). 12, 79-125. 9½". 50c.
- Effect of fertilisers on growth of hevea: a study in combination of data from a heterogeneous group of experiments. *J. Rubber Res. Inst. Malaya* (1950). 12, 127-166. 9½".
- SOVANI (N. V.). Planning of post-war economic development in India ... Poona, Gokhale Institute of Politics and Economics, 1951. xi, [iv] 106 pp. 8½". 5s. (Publication, 22.)
- SUTHERLAND (HALLIDAY). Control of life ... with two chapters by Henry P. Newsholme ... newly revised and enlarged ed. London, Burns Oates, 1951. xiii, 282 pp. 8½". 15s.
- SWERLING (BORIS C.). Some limitations of competitive equilibrium. *Southern Econ. J.* (1950). 17, 33-43. 10".
- THOMPSON (REGINALD W. S.) and THOMSON (D. HALTON). The application of statistical methods in the determination of the yield of a catchment from run-off data: by R. W. S. Thompson, with a statistical note by D. H. Thomson. *J. Inst. Water Engin.* (1950). 4, 394-428. 8½".

Journal of the Royal Statistical Society

SERIES A (GENERAL)

PART IV, 1951

INDICES OF WHOLESALE PRICES

By J. STAFFORD

[Read before the ROYAL STATISTICAL SOCIETY, May 23rd, 1951, the President,
Professor A. BRADFORD HILL, D.Sc., Ph.D., in the Chair]

Earlier History in the United Kingdom

1. THE first wholesale price index constructed by a government department in this country, so far as I have been able to trace, was prepared by the Board of Trade and published in 1903 in a parliamentary paper on Wholesale and Retail Prices. The series, based on 1871, covered each year to 1902, and represented the weighted arithmetic mean of price relatives of 45 commodities, mainly basic materials and foodstuffs. Prices were largely derived from the trade accounts, that is, were, for the most part, average values as recorded at import or export, though it is interesting to note that prices of milk and potatoes were obtained from the records of certain hospitals. The weights used were the estimated values of the different commodities consumed, or used, in the country in the years 1881-1890. Some adjustment was made to avoid so-called double counting, e.g., the weight for coal was abated by the value of coal used in pig-iron production, that commodity being one of the 45 chosen.

2. The publication of this index was, however, noteworthy for the extremely interesting, learned and still instructive paper written by Sir Henry Fountain, the then head of the Statistics Division in the Board of Trade, which was reproduced in the paper to which reference has been made. He recalled that Jevons's two notable papers on index numbers, the second of which was read before this Society and published in 1865, argued the case for geometric weighting in terms of the purpose the index was designed to serve—namely to assess the effect of gold or monetary supply upon prices. The gold supply, Jevons argued, affects all prices in equal ratio; and it is this unique ratio which is to be measured. Other disturbing causes will affect these ratios, in opposing senses and in different degrees, and it is the resultant of all these ratios, properly balanced, which will indicate the effect of gold supply. It is the geometric mean which offsets a doubling of one price by a halving of another, and it is therefore an index so constructed, and unweighted, on which Jevons decided. (Even an index constructed of price relatives is, of course, in practice weighted by the process of selection, but ideally for this purpose the composition of the index would be limited only by the availability of data.)

3. Fountain doubted "having regard—amongst other considerations—to the very different sensitiveness to currency changes of different commodities, whether a random selection of commodities can give any result capable of interpretation". He adopted, therefore, a more practical standpoint and chose a consumption standard as his reference of measurement. "The true measure in the change of the value of money is the change in the amount of gold that must be paid by consumers (no doubt including investors) throughout the country for all commodities in their finished state consumed by them per unit of time". In practice, one must approximate to this by sampling. And because prices of finished goods are not available, raw materials must be priced. To Professor Nicholson's objection that raw material prices will not reflect the increasing efficiency which is notable in manufacturing industry, Fountain urged that changes in

the efficiency of transport play an important role in determining the longer term movements in prices of materials; and that, in general, though the prices of crude materials may fluctuate more, their trend may not be so different as Professor Nicholson supposed from that of prices of manufactures. These considerations, together with the convenience of having price relatives for individual commodities, determined the form given to the index.

4. This index was continued substantially unchanged until 1921, when a new index was prepared and described in a paper read to this Society by Sir Alfred Flux. The new index was weighted in conformity with the results of the first Census of Production of 1907, was revised in 1935 with weights from the 1930 Censuses of Production, and has been continued to the present time with improvements, but on the same basic pattern. The structure of this index will be well known to Fellows of the Society. A second paper on it was read by Sir Alfred Flux in 1933, and a fairly full description was published in the *Board of Trade Journal* in January, 1935.

The Present Index

5. When the pressure of war-time work relaxed a little, attention was turned to a review of the wholesale price index, which but for the war would have been revised to incorporate the results of the Census of Production for 1935. The existing index was, and still is, based upon 1930, with weights largely derived from the Census of Production of that year. By the end of the war, therefore, the revision of the index had become very necessary, and a decision had to be taken whether this work should conform to the pattern followed since 1921, or whether an index in a new form should be established.

6. The method of construction of the existing index has been a limitation to its usefulness in economic analysis in that the price changes it seeks to measure are not in general relatable to the most significant selections of commodities or disbursements of money. The index can be regarded as being built up from a number of sub-indices related to particular industrial or commodity groups, *viz.*, coal, iron and steel, cotton, etc. The primary weighting of the index is obtained by giving to each group a weight based upon the volume of production in the industry group, or upon usage in the case of commodity groups (net of duplication). Adjustments were made to these group weights to avoid duplication of weights between groups. Within the individual groups were made selections of commodities or goods consisting of what are commonly regarded as raw materials and manufactures in a more or less finished state; so that the cotton group, for example, consists of a selection of varieties of raw cotton, yarn and cloth. Within these groups, weights for the different goods were again chosen to avoid duplication, so that, e.g., the weights given to cotton cloth and yarn represent, not the value of cloth and yarn which were produced, but that value abated by the value of the raw cotton content in the case of yarn, and by the yarn content in the case of cloth. In some groups the basic material is overweighted because of the difficulty of obtaining price series for fabricated products; and, generally, partially fabricated products are overweighted compared with finished products for the same reason.

7. The index representing the average movement of these industry indices (other than the food and tobacco groups), which is designated the Industrial Materials and Manufactures index, is, apart from the fuel items, cross analysed, according to the stage of manufacture, into indices for basic materials, intermediate products and manufactured articles, the various commodities and goods included in the industry groups being allocated with their weights to one or other of the three sections according to their respective degrees of fabrication. The index for all articles (and commodities) is simply a composite of all the industry groups and the groups for fuel, food and tobacco.

8. There are a number of disadvantages in this system. The goods represented in the industry and commodity groups are at various stages of fabrication, so that the movements in the sub-indices represent neither changes in prices of materials used nor of goods produced. The result of the device adopted for avoiding duplication is that the indices cannot attempt to measure changes in the prices at which all transactions take place in these commodities or industries. At the same time, only the weights are free from duplication; the effect of changes in raw material prices on the prices of the more finished products within the group tend, of course, to be reflected in the index. It is, of course, impossible to achieve by adjusting weights the object which appears to have been generally sought by compilers of index numbers, namely to prevent price changes of

1951]

component materials having more than their direct effect on the index. Again, the adoption of netted weights does not convert the group numbers into synthesized indices of price changes of the more finished products (or rather more accurately of the price changes which would occur in finished products if changes in raw material prices had no indirect effects, e.g., through margins or commissions, on the prices of those products). This kind of index could, in theory, only be compiled by adopting a system of netted weighting, and including, not the prices of the finished products, but the values added to materials per unit quantity at the successive manufacturing stages. In practice, of course, this procedure would be an impossible one to follow, because of the lack of information, even if it were a desirable one.

9. The netted weighting has, of course, an effect upon the sectional indices by stage of manufacture. The basic materials index is least affected and has a more consistent set of weighting for its components (though some materials carry too great a weight in order to make good in the all articles index for the deficiency of fabricated goods made from them). For the other sections, the system of net weighting has the disadvantage that the importance given to a product does not reflect the value of the material of which it is composed. And, the weighting in the two final stages is affected by the proportionate weighting in the various groups carried by commodities at the earlier stages under the influence of the availability of price quotations.

10. What has been said about the group indices applies with perhaps more force to the all articles index. What has often lain behind the construction of wholesale price index numbers both in this and other countries has been the importance of changes in the value of money arising from changing monetary conditions, and the belief that changes can or should be measurable by a relatively simple formula. Sometimes an index has represented the belief that these changes can be measured tolerably well by the reciprocals of the movements in the prices of a relatively small number of staple commodities, with markets sensitive to monetary or credit changes. This represented a development on the old device, adopted for want of better information, of measuring the purchasing power of money in terms of, e.g., wheat. Sometimes the index has been influenced by Irving Fisher's approach to monetary theory, and has represented an attempt to measure the changes in average prices underlying all transactions, or at any rate all commodity transactions; although, of course, because of the paucity of data, even this has been impossible to achieve because even when the quantity of a commodity used is known, the volume of transactions in that quantity is not. Again, wholesale price indices have been notably used for indicating changes in the purchasing power parities of currencies. To be useful for this purpose a much more careful and a much wider selection of goods than is commonly chosen would be required, as well as a quite different system of weighting. The thought underlying the index prepared by the Board of Trade was explained in the paper read to this Society in 1921 by Sir Alfred Flux, who said that a well-constructed index might be expected to answer the question, "What is the average change in the value of money relative to other things", and that it might do this by averaging the price movements of a large number of commodities, the commodities being weighted in rough proportion to their importance in the economy.

11. No one, I think, would ever attempt to construct an index number as a unique measure of the change in the value of money after having read Lord Keynes's famous chapter on index numbers in the *Treatise*. From different points of view, different degrees of change will be observed—prices of imports will not necessarily move similarly to those of exports, changes on organized markets may be very different from those of manufactures, and so on.

12. For these reasons, we have decided to bring to an end the series started in 1921, and in the new work to adopt a different approach. We have not taken as the ultimate objective the construction of one final wholesale price index, but have determined upon the construction of a family of index numbers, each of which we hope will be helpful to industry and government and be a useful addition to the armoury of the economist. Whether an all-articles and all-commodities index will be constructed may be determined less by a dispassionate view of what such an index might measure than by the fact that users of economic statistics would feel the loss of this convenient, if now not quite respectable, series.

13. An all-articles index is open to the criticisms which statisticians have attempted to turn by net weighting. Price changes of a raw material have their effect on the index at each stage at which the products of the material are dealt in. The purchase of weaving sheds by spinning mills, and similar transfers of ownership, can affect the relation shown by such an index, if the

statistician is unsuccessful in ensuring a complete separation of these and similar activities in taking censuses of production. An industrial subdivision of an all-articles index will measure the change in the average purchasing power of a unit of money spent in effecting a transfer of goods anywhere in this chain, from the materials to the finished products. Is this a measure of something in which there is interest, either in the industry or by observers of economic affairs? Is not the average of all these industrial changes, which is measured by the all-articles index, even less useful than its industrial components? All that this index appears to me to provide is an approximation to a substantial—the commodity—component of the Fisherine P, one of the variables in an identity. It is a summary measure of all commodity price changes, but in summarizing all changes the economic significance of them appears to be lost.

14. The design of the new index numbers has been determined in the light of the purpose for which index numbers are now required. In conjunction with statistics of the value of output derived from, e.g., censuses of production, indices are required for estimating changes in the quantum of production, or for estimating changes in the quantum of goods used for certain purposes, e.g., for consumption and investment. They are required for measuring changes in the prices of materials and fuels used in our industrial economy, or for a number of more detailed purposes of a similar nature. The preparation of composite indices of these kinds are not the only objects of value to be secured from the work involved in their compilation. An almost equal interest can attach to the preparation of series showing the price movements of important individual commodities. We have in general avoided the preparation of group indices following some pattern of classification unless some specific purpose appeared to be served.

Indices of Materials

15. For the construction of indices, goods will be grouped according to their economic characteristics or the purpose which they serve in the economy and not according to their physical characteristics, whether natural or as influenced by manufacture. It is intended to construct two broad families of indices. The first will be one relating to goods, whether home-produced or imported, which are used as materials by British manufacturing industry, considered as a single entity. Goods at various stages of fabrication will, of course, be included—quarry, mine and farm products of this country so far as they are relevant and imported materials and manufactures used in the industrial process. From these will be constructed an index of basic materials used in manufacturing. This parent index will reflect price movements of goods primary to the complex of industry so defined. (It excludes fuels, which are treated separately.) Semi-manufactures of British industry which are the finished products of one industry (or firm) and the materials of another will be excluded from this index.

16. In an economy as dependent as ours upon imported supplies, it may be helpful to analyse this index from time to time into the price movements of the imported and of the domestically produced component goods. However, the index will be so largely weighted by imported materials that the preparation of two regular series, for the overseas and home components, is not thought, at this stage at any rate, to be necessary. There are, of course, available regular price series for imports; and some confusion might arise between a wholesale price index for imported industrial material and the longer established price and average value series derived from the Trade Accounts.

17. This index will be sensitive. For example, six commodities, cotton, hides, softwood, hardwood, woodpulp and wool will carry about half the weight of the basic materials index. The weighting system adopted will need to be kept under review by calculating, if only approximately, and comparing its movements with the relevant Paasche index. In the appendix to this paper figures are given from August, 1949, to February, 1951, for the new and the old basic materials indices. It will be seen that until June, 1950, the old index was recording increases fractionally below the new, but that since that date the old has indicated a much more considerable rise in prices. That these divergences should have occurred will not be unexpected; the indices are not really comparable, their weighting is very different, and a large part of the disparate movement over the recent past is the result of the large weight carried by woodpulp (to which was attributed the weight for paper-making) in the old index. Though having a contrary effect, the weight for wool in the old index was, of course, much smaller; the weight set down for the existing index against wool in the table includes a weight for tops.

1951]

18. In addition to these composite indices there have been prepared for publication price indices for individual basic materials derived from averaging the price relatives of the different grades and varieties of the commodities. These will cover a large proportion of the input of manufacturing industry. It is hoped that these will prove useful to industry.

19. For two important industries, electrical and mechanical engineering, indices have been prepared and published of the prices of materials used (other than fuel), in these cases including manufactures of other British industries. For building and civil engineering indices have been prepared in conjunction with the Ministry of Works both for all materials and for materials used in house-building, and these may have been published before this paper is presented. Largely depending upon the needs of industry, further indices of this kind may be prepared, though it may be that the individual commodity series referred to earlier may make this unnecessary.

Indices of Final Goods

20. The second major complex of indices will relate to the output of manufacturing industry and the usage by the economy in its role as consumer of or investor in final products. The first of these indices will reflect price changes of manufactured goods produced for the home or export markets by all manufacturing industries considered as a single entity. The goods priced will include, besides final products, partially finished goods so far as, but only so far as, they are exported. It may be possible and useful to analyse the movements in this index by preparing sub-indices for the final products of some major industries or groups of industries whose products are subject to broadly the same influences; this will depend in part upon the adequacy of the price quotations which are available. It is not proposed to produce sub-indices with a broader coverage relating to groups of industries which because of the nature of the processes of or the materials used by their component industries, are subject to quite diverse influences upon the prices of their products. It does not appear to be useful, for example, to prepare indices for the products of the textile industries as a group, or for the food, drink and tobacco industries as a group. Apart from the preparation of indices for the products of more homogeneous groups, it will, it is thought, be more useful to prepare indices relating to specific products, analogous to the indices for individual materials included in the basic materials index. A gross weighting system will be used for indices of final products, i.e., goods will have an importance reflecting their sales value. No adjustment to the weights will be made for the value of imported materials incorporated in these commodities. To do this would impair the usefulness of the index, e.g., for making estimates of the changes in the quantum of output of finished products. A net weighted index could not, of course, be used as a means of deflating changes in the value added by industry to imported materials.

21. In addition to these indices relating to output, it is proposed to construct an index, with sub-indices, related to the usage of final goods by the economy, whether home-produced or imported. The goods brought within the compass of the index will include, as well as the final goods of manufacturing industry used by domestic consumers or investors, domestic farm and primary products taken by consumers, and imported products of whatever kind passing directly without manufacturing process to consumers and investors in this country.

22. Sub-indices will be constructed to show the relative price movements, within this heterogeneous selection of goods, for consumption goods and, so far as practicable, for investment goods. In addition, it is hoped to prepare a series of finer indices for the main categories of goods entering into personal consumption, e.g., clothing, radio apparatus, food, etc.

23. It will be observed that intermediate products enter into both the main indices described—imported products into the materials or "input" index and exported products into the manufactured products or "output" index. For these purposes it has been necessary to collect prices for a wide range of important intermediate manufactures. So far as possible separate indices will be prepared and published for the more important categories or groups of kindred goods of this kind, e.g., cotton yarn, and iron and steel products. In the construction of these separate indices the weights of the varieties included, e.g., the different counts of cotton yarn, will reflect the national production (or where appropriate the national usage) and not the composition of the export trade.

24. Little significance is thought to attach to a composite index of prices of intermediate manufactured products, whether used or produced by British industry, or both combined. Transactions in intermediate products are to a large extent dependent upon the institutional rather than

the economic structure of the economy. The flow of intermediate products as a whole is not the counterpart of any significant stream of money whose changing purchasing power is a matter of economic interest, in the same way as is the expenditure by industry on materials or by the consumer on final goods. However, the preparation of indices for final goods will necessarily be a much more difficult and protracted task than has been the preparation of the basic materials index, or would be that of an intermediate products index. It may, therefore, be worth while to prepare, as no more than an interim measure, an index for these products so that false impressions may not be gained from the sensitiveness of the basic materials index.

25. With this one exception, all the indices indicated are designed to show the average change in the prices of a specified flow of goods. Without exception the weights attached to the prices of particular commodities will be gross weights, reflecting the quantity or the value of the commodity which is used, produced or consumed, as the case may be, in a given period of time. Among other advantages, this procedure has the importance of being explainable and, what is perhaps different, understandable.

The Arithmetic or Geometric Mean

26. A departure is also being made from past practice in preferring the arithmetic to the geometric mean of price relatives, which is the method of construction at present adopted. The advantages of the latter method have not been thought sufficient to offset what is considered the considerable drawback of unfamiliarity. The concept lying behind the weighted arithmetic mean is now tolerably well understood in economic affairs. The disadvantage of a base weighted index having an upward bias is the obverse of this advantage, and appears to be better controlled by such frequent change of weights as the changing pattern of the economy may suggest, rather than by calculating a geometric mean with, perhaps, a less marked bias.

27. The geometric mean was preferred for the existing index because, in addition, the index so computed was reversible, i.e., the ratio between the indices for any two periods is unaffected by the base year chosen, and substitution of one price series for another can be effected easily, particularly when the calculations are made by a chain method. In fact, an arithmetic mean index with fixed weights will show this quality of reversibility, and there are no difficulties presented by substitution, which can be brought about by an appropriate adjustment of the base year price, i.e., the creation of a conventional price. A price index can never be more than a rather imperfect tool for assessing price changes. One of the really important characteristics to be looked for in an index is an easily identifiable method and basis of construction, so that the user can judge whether it is suitable for his purpose, whether it is likely to show some deviation from the course he wishes to have traced, and what adjustments should be made to it if it is to be more appropriate. If this is so, there seems to me to be much to be said in favour of a base weighted arithmetically averaged index.

Weighting

28. The most convenient, comprehensive and accurate information for the preparation of weights for the indices was for the year 1948, for which were available the results of the first census of production taken under the Statistics of Trade Act, as well as other information, notably about our overseas trade. That census collected much more detailed information about the purchases of materials by as well as the sale of industry than had previous censuses or inquiries. A 1948 weighting system was in fact the only one available, or likely to be available, for some time, as the censuses both for 1949 and 1950 will not be suitable for this purpose for the reason that detailed information on sales and purchases was not collected. With the much fuller information available from short-term statistics than before the war, it might, with considerable labour, have been possible to estimate weights applicable to the year 1949, but in many instances these would necessarily have been rough and unsatisfactory, and perhaps have been based upon too great an element of judgment.

The Base Period

29. Just as the system of weighting was virtually chosen for us, the price base has been largely imposed by circumstances. As was expected when the work was begun, it was much easier to

1951]

collect prices which were current or for the immediate past than to obtain a record running back well into the past. Many of the price series made available to us start about the middle of 1949, though some can be carried back to earlier periods; and it is unfortunately to be expected that some will not be carried back so far. The devaluation of sterling which occurred in September, 1949, had, of course, a marked influence upon prices, particularly of imported materials and foodstuffs, and made inadvisable the choice of a base period which straddled this important event. Moreover, it was important to measure as accurately as possible by the new indices the effect of devaluation upon the price structure of the United Kingdom. For these reasons, therefore, it was decided to adopt the middle of 1949 as the base of the indices which will first appear.

30. The base of price index numbers is commonly provided by a much longer period, in some cases by the average prices of a decade, so that it is, perhaps, not inappropriate to say something in defence of a shorter period. In the first place, such a base as we have chosen is more easily appreciated. Even the average of prices of as short a period as a year, in the changing post-war world, can fail to present a very clear picture to the mind of the price structure against which changes are being measured. In the second place, simple averages themselves are misleading. The business of the period is unlikely to be done at the average prices of a period of changing prices. Of course, to the extent that particular prices in the short period chosen are markedly out of line with prices ruling around that period, the first advantage is to some extent lost; and a short period has its own disadvantages for seasonal commodities, of which there are fortunately few in the indices. The determination of a base will, however, have to be made once more when the indices are rebased and reweighted, and it is to be hoped that then the decision will be less trammelled.

The Form of the Indices

31. These decisions and the interest in individual price relatives suggested that the form of the indices should be a weighted arithmetic mean of price relatives, the weights being expenditures in 1948.

32. The indices have, therefore, been calculated on the pattern—

$$I_x = 100 \frac{\sum Q_{48} P_{48} \frac{P_x}{P_{49}}}{\sum Q_{48} P_{48}}$$

and the indices can be described as measuring the change in expenditure in the pattern of 1948, occasioned by price changes relative to mid-1949. This is not so readily imagined a concept as that applicable to an index whose weights and base both related to identical periods and which is considered in its aggregative form. The measurement of price changes in terms of the change in cost of purchasing a fixed bundle of goods is one that has obvious and real advantages. The form chosen can, of course, be transposed into an aggregative form, but with no marked expository advantages. It can be written:

$$100 \frac{\sum \frac{P_{48}}{P_{49}} Q_{48} \cdot P_x}{\sum \frac{P_{48}}{P_{49}} Q_{48} \cdot P_{49}}$$

The index represents, therefore, the change in cost relative to mid-1949 of buying, not the bundle revealed to have been purchased in 1948, but such a bundle as might have been bought at the base date, if, other things being equal, each constituent commodity had unit elasticity of demand with respect to price between 1948 and the base date.

33. If the base of the index of the form chosen is changed a different measure of price changes is established. (This was a criticism levelled by Sir Alfred Flux against Sir Henry Fountain's index.) If, for example, the base were shifted to the post-devaluation year of 1950 the index could be written alternatively as—

$$100 \frac{\sum Q_{48} P_{48} \frac{P_x}{P_{50}}}{\sum Q_{48} P_{48}} \quad \text{or} \quad 100 \frac{\sum \frac{P_{48}}{P_{50}} Q_{48} \cdot P_x}{\sum \frac{P_{48}}{P_{50}} Q_{48} \cdot P_{50}}$$

and the index will then measure the change in cost of a bundle of goods which would have been chosen in 1950, other things being equal, if each constituent of the bundle had unit price elasticity between 1948 and 1950. The index itself can be described as measuring the change in cost of buying the different bundle of goods referred to in paragraph 32.

34. The failure of the index chosen to meet this so-called test is not, I think, a very serious defect. Between any two periods a great many price relations can plausibly be established. That an index of this form gives a second relation when its base is changed is really no more important than that any other index with a different weighting system would also be likely to give a different result. A Laspeyre index with weighting system and base of a common period needs continually checking to ensure that its system of measurement is maintained relevant to the times for which it is being used. These new indices will also need revision—the more so, no doubt, as the pattern of expenditure chosen has antedated the base from which measurement begins.

Sampling of Prices

35. For a number of practical reasons, the construction of wholesale price index numbers involves the choice of commodities to be priced. In the field of manufactures there is a very great number of goods which can be regarded as different commodities. For many, particularly the more elaborate or specialized products and even for commodities which are superficially simple and homogeneous, there are, of course, very many varieties, grades or sources. The reporting of price changes places a task upon the industries and firms co-operating which it is clearly desirable to avoid making unduly burdensome. The multiplication of price quotations, whatever the resources available, must tend to delay the preparation of the index number, if only by increasing the number of problems which demand both careful and tolerably consistent solutions. For all these reasons, it is necessary for a statistical office to exercise severe self-discipline in determining and limiting the number of price series to be used, whatever may be the theoretical advantage of casting wide the net.

36. This necessity to choose immediately poses the problem of how to apportion the weights of the uncovered commodities. In the preparation of this kind of index, more than in that of volume indices of external trade or indices of production, the balance of advantage seems clearly to be in a decision to allocate the weights of uncovered commodities among those for which price quotations are obtained. The reasons for this view indicate, of course, the principles to follow in making the allocation.

37. The primary conditions to be satisfied for the satisfactory allocation to a price series of weights for other commodities is that the group so isolated should have its prices subject to common influences, ideally from both sides of the market. In practice, of course, it is only possible to ensure that certain important influences are alike, e.g., the material incorporated or used to produce the goods, the systems of wage rates payable to the labour forces employed, and, in a broad way, the techniques of manufacture. It is, often, particularly in the case of manufactured goods, impossible to ensure that conditions of demand will not move very differently for apparently very similar goods, e.g., woollen and worsted cloth, so that, particularly in shorter periods, aberrations in the movement of the index must be expected to occur. Similarly, of course, technical changes in production may disturb the accuracy of the index, particularly on the timing of price movements if the commodity chosen is the one of the first subjects for new technical methods of manufacture. The main remedies for these troubles must be scrutiny of the series incorporated, and as close a contact as can be achieved with industrial conditions, a willingness to substitute for a series which is behaving badly, and as wide a selection of price series as other considerations permit. Because, however, of the importance of common cost elements, the balance of advantages surely lies in the specific allocation of weights of unpriced goods within a group, and where applicable, grouping according to an industrial classification which itself reflects the common cost influences. For example, within a clothing index, the goods should be stratified into products of the hosiery trade, of the different component materials, heavy and light clothing, again with subdivision where appropriate by material, rainwear, hats, etc. Stratification in this way will assist the determination of weights and the proper apportionment of resources in obtaining price series.

1951]

The Collection of Prices

38. The critical operation, and in practice the major one, is the choice and collection of the price series. Perhaps the two most important desiderata in the series are comparability over time, and importance of the commodities or varieties in the markets, so that series of effective, and not dummy, prices are obtained, and markets are broad enough to respond to influences affecting prices. The collection of prices, however, poses other problems, not all of which can be solved to the satisfaction of the statistician, e.g., the point of pricing, ex-works or delivered, the size of transactions for which quotations are required, and the problem of reflecting transactions arranged on special terms.

39. On the choice of the important commodities, the available statistics, and particularly the results of the Census of Production for 1948, are a good though not sufficient guide, as more detailed commodity analysis is required than is always available. In choosing commodities very considerable and quite invaluable assistance has been given by industrial associations and individual firms.

Changes in the Specifications of Goods

40. To ensure comparability of price series presents considerable difficulties, theoretical and practical, as a result of changes taking place in the nature of the article or commodity priced. These specification or quality changes raise the question of what is to be priced? A manufacturer producing some simple machine as a standard line may, as a result of an improvement in design, devise and put into production a cheaper but equally serviceable and efficient model. The old model may be continued for a number of good reasons, e.g., as a replacement for some more complex equipment in widespread use. How should a change of this kind be treated—a new price series on the new model be grafted on to the old series, without, however, bringing into the index the fall in price on the introduction of the new model; or should the new model be taken as the equivalent of the old and the price fall on the switch be shown in the index? If the rule is to price rigidly on a precise specification the former alternative will be adopted, and the index will measure changes in costs of input, factory efficiency and market conditions. But it will ignore those reductions in price which come from designing for production requirements, two very potent forces working towards a reduction in costs and prices.

41. A partial solution to this problem appears to be the adoption of a rule of technical equivalence—accept the new thing as a complete substitute for the old if it broadly does the job of the old. But this rule can only take one part of the way home. Many consumer goods are designed to certain technical standards, e.g., radio sets. The rule, therefore, would suggest that a new and old model should be substitutable if broadly they conform to the same standards—so that the new set with, for example, a better designed and cheaper circuit replaces the old. The final purchaser, however, is not interested solely in performance; he may, even, because of past designs or publicity, be interested in certain symbols of technical standards, so that the new model may appear to him initially at any rate, less desirable than the old; and of course, he is interested in appearance.

42. Moreover, improvements of the kind under discussion are by no means confined to designing a cheaper thing to do the same job—the cheaper thing may do a better job, or a job in some respects better and in some worse, or a rather different job, or a rather worse, but still generally good enough job. A new model of motor vehicle, for example, may have certain better and other less good characteristics. It will clearly often be extraordinarily difficult to pose to the manufacturers the query, the answer to which might give the statisticians a reasonable solution to these problems,—“If this new design had been modified to give an identical performance to that of the old model, how much would you sell it for, on the same commercial principles which have determined in fact the pricing of the new model in production?” The answer to this question would involve, among other labour, redesigning the car.

43. The rule of technical equivalence breaks down completely over a wide range of consumer goods, e.g., women's fashion goods. For these goods, where fashion or appeal to the consumers is so important, one is faced broadly with two possible alternatives, neither giving very satisfactory answers. First the utilitarian's solution, to ask, for example, the manufacturer to price the line most closely comparable from year to year in terms of the market served, in the belief or hope that

whatever the styling or, within limits, the quality of the material, a cotton dress in a given quality range sold in 1951 is the nearest substitute to one in that range sold in 1950, and that both give much the same satisfaction to their purchasers. Secondly, one might ask the manufacturers the cost relation between the new and the old if both were produced at the commencement of the 1951 season, and use the difference in cost as a measure of the difference between the two articles. The provision of information of this kind is, however, likely to be troublesome to the manufacturer, and cannot be expected to provide a generally applicable method. A variant of this second procedure where identifiable variations in specification occur, e.g., from a car with sunshine roof to one without, would be to allow for the change on the estimated differential in selling price. Or again, where there is an ascertainable change in quality, e.g., of cloth in a garment, it may be possible to change the position in the range of models of the variety chosen to continue the series. Sometimes different methods of allowing for specification changes will pull in different directions; for example, the substitution of a lower quality cloth in a garment may increase the durability of the garment and improve its quality in the eyes of many consumers. So far as possible it is wise to choose goods to be priced with the object of avoiding these troubles; standard designs may be chosen for decorated pottery, but one must be careful not to exclude goods appealing to growing markets, for that is where price sensitivity may be found.

44. The first treatment will tend to stabilize the index because for price changes there will, in both directions, be some tendency to substitute quality changes. The second would have an opposite effect on the index: in time of rising prices, economies resulting from manufacturers' efforts to substitute an inexpensive for an expensive styling quality would not be reflected in the index. The choice between these different approaches, which may be called the utility method and the cost differential method, would be made if it were possible, according to the purpose to be served by the index. The former seems more appropriate where the index is to be used in an estimate of changes in the volume of goods consumed or installed. The second is, perhaps, best used in the calculation of changes in the quantum of output. The technical equivalence method can be represented as appropriate for both purposes.

45. An apparent method of avoiding many of these difficulties is to take a number of price series for different varieties of an article or for different models from several manufacturers, and to average these, or their relatives, into a series for a particular "commodity". If an individual variety or model behaves badly, it can be suppressed in the knowledge that there are several other strands in the rope. This is a useful device, but one which cannot be too often used without creating other difficulties. As indicated earlier, this practice may give the index a quite spurious stability, if price changes are commonly associated with changes in specification. This is likely to be true if, for example, reduction in cost is made possible by change in design; or if an increase in costs of production are offset by an alteration in material components, e.g., the admixture of other fibres with virgin wool on a rise in the price of wool. The result would tend to be that the variety causing the change in price or quality would drop out of the index during the change. Moreover, there is, in many markets, a seasonal pattern common to many manufacturers in which new models at new prices make their appearance at much the same time; and where this is so, all the strands of the rope break simultaneously.

46. The uncomfortable conclusions to be drawn from this discussion are that it is not very meaningful to price precisely the same thing over a period of time, when purchasers are not buying the same things and when price changes often coincide with changes in specification; that the substitution of technically equivalent things is a solution of only limited value to the problem of change; that to concentrate on satisfaction to the consumer rather than the make-up of the article allows fluctuations in quality to stabilize the index; and that data on cost differentials may be hard to secure, as well as often being accompanied by other effects.

47. The inclusion in the index of highly fabricated goods does not create these troubles: it simply makes the statisticians face them. Simple products, traditionally included in indices, are subject to change, from season to season, because of the weather; or over long periods, because of better seed or better grading; or within a season, because the best of the crop is sold first.

48. It would be pleasant to think that there is an answer to the question, "What should be priced when the things on the markets change gradually or suddenly"; but I believe that the best that can be done is to consider each change as it occurs, treating it so that so far as possible quality changes do not mask price movements, accepting some quality changes as concomitants

1951]

of price changes, accepting the fact that some conventional ideas of quality are not necessarily very important, and accepting, too, that the statistician cannot expect to get much supplementary information, and cannot therefore expect to do even as good a job as he knows how to do.

49. Specification changes in extreme cases become complete, and virtually unbridgeable discontinuities occur in the nature of goods for which continuous price series are required. Heavy engineering products built to specification can provide an example of this; but fortunately, there is good reason to believe that kindred goods, subject to much the same price influences, can be identified, and for which a practicable approximation to continuity can be found. In the field of finished goods there is, perhaps, the greatest difficulty in obtaining satisfactory price series for building and civil engineering works. Of their nature, each job has its peculiarities of site or structure, and there are obvious disadvantages in the use of quantity surveyors' estimates, which must be based upon assumptions about the progress of the work and cannot adequately allow for changes in gross profit margins.

Errors

50. The commodities to be priced have to be chosen largely upon the advice of traders, and there is a possibility that this may introduce a bias in price movement, e.g., the goods chosen may be the most sensitive in a range; there appears, however, to be no practicable way of making the sample random. The use of list prices or quoted prices also introduces a source of error. Trade discounts which are recognized and published may be allowed for, but prices to specially favoured customers or negotiated prices, in practice, cannot. These divergences from list prices will vary in importance from trade to trade and from time to time; in highly competitive conditions they may be of great significance. The indices which these conditions affect will be unduly stable when prices fall, and will not show a sufficient rise when they recover. Export prices are inadequately represented in the index, because, for many goods, of the difficulty of securing prices, since the sales are against contracts each of which may have its own price, and prices of similar contracts may vary between markets. Under present conditions the effect of this may be to damp down unduly the movement of the indices affected.

51. An important issue is raised by the very varying volume of transactions which take place at different times and at different prices in the market. The customary procedure for pricing is to take reported prices, opening, closing, actual or average according to the nature of the market, on certain days of the month. Markets may, however, be very thin and prices nominal even for extended periods, and this may well happen at peaks and troughs of minor or major movements. To give equal weight to all quotations may, therefore, exaggerate the movement in effective prices. This is a very serious disadvantage, which can, however, only be put right by using information about the volume traded in the market—data which unfortunately are only rarely available. Impressions about the slackness or activity of the market can, of course, sometimes be given; but generally these are much too insecure and imprecise for the statistician to dare to use.

Quoted Prices

52. Prices used in the indices are quoted prices (on conditions determined by trade practice, e.g., ex-works or delivered), that is, they represent the terms on which business is being arranged, and not the prices being received against deliveries currently made. This procedure is, of course, a disadvantage in that it makes the indices less appropriate for some important purposes, e.g., as deflators of money flows against goods bought and sold. It also casts doubt upon the wisdom of using price quotations, instead of average values, in indices of the prices of exports and imports. In practice, however, there is no alternative. There is much greater, though by no means perfect, uniformity in quoted prices than there is in prices paid. At any one time manufacturers may be buying identical materials or selling identical products at different prices under different contracts arranged at different times. It would be impossible to secure the average of prices paid or raised; and if these were secured, there would be the difficulty that price changes as revealed by the index could be affected not by the forces influencing the market from month to month, but by the disposition of deliveries against outstanding contracts.

Seasonal Commodities

53. The problems posed by seasonal commodities, fortunately, do not bulk very large in

wholesale price indices. There is no wholly satisfactory way of incorporating the price changes of these goods into the index. Substantially, a choice has to be made between seasonal alterations in the composition of an index to allow for the appearance into and the disappearance from the market of these commodities, and the use of dummy prices to maintain price series for seasons where there are no market prices. In either case there is the subsidiary problem of delimiting the seasons and determining when the commodity has appeared or disappeared. On balance, the former course seems preferable, so that a weight would be attached to the commodity for those months when it was actively dealt in, though there is something to be said, if only on practical grounds, for using dummy prices for goods which disappear for short periods. When out of season, the weight would be allocated, according to the circumstances of the case, to a closely related commodity (new and old potatoes), or to a sub-group (brussel sprouts to the vegetable group) perhaps to the main group or to consumption expenditure as a whole (strawberries entering as such into personal consumption). The disadvantage of this treatment is, of course, that price changes between one month and another as shown by the index will relate to different parcels of goods, and the index may fall when new potatoes first appear (if they are then cheaper relative to the base date than other goods carrying their weight) and rise when they disappear.

54. The alternative is to maintain the weight of new potatoes throughout and use a dummy price in the off season, e.g., the last price from the old season (though, of course, dummies constructed in other ways can be used). The main objection to this course is that the index cannot pretend to be a faithful measure of change compared with its base or even from month to month, if only because its weights are distorted by the retention of unavailable commodities.

55. This paper is mainly descriptive of the problems encountered in constructing the new indices. It has not been possible, as I should have wished, to present the results of this work. Indices of materials used in the electrical and mechanical engineering industries have been published in the *Board of Trade Journal* in September, 1950 and January this year. Only provisional figures for the new basic materials index were available when this paper was prepared, and this is presented with a table showing the provisional composition and weighting of the index as reproduced,

New and Existing Indices of Basic Materials
(Mid 1949 = 100)

	<i>New</i>	<i>Existing</i>
1949		
August	97·2	97·2
September	100·4	100·3
October	106·7	102·4
November	109·8	104·6
December	111·4	106·5
1950		
January	115·8	110·6
February	115·8	110·9
March	116·3	111·6
April	119·7	115·8
May	124·7	121·8
June	126·8	125·4
July	133·6	133·7
August	142·3	146·8
September	159·6	160·5
October	165·8	170·8
November	180·3	189·5
December	183·0	196·6
1951		
January	202·7	215·5
February	212·8	229·0

1951]

which will show some changes in their final form. It is hoped to publish shortly a full description of this and other indices, with details of the commodities included and the weights used. The interest which exists in individual price movements is appreciated and, subject to the limitations which must be imposed to safeguard the confidentiality of some of the information supplied, particularly about manufactured products, it is hoped to arrange publication in some form. The need for indices of the kind proposed has recently been emphasized by an interesting paper by Mr. H. J. D. Cole* in which are constructed indices of machinery prices from average values derived from the Trade Accounts. The author makes a plea for better price indices than these data can provide, in order to assist in the study of investment in real terms. These are, however, among the more difficult indices to prepare, and it must be some time before they, or similar indices, can be made available.

56. In the preparation of the new indices, the Board of Trade has had the benefit of the help and co-operation of the statisticians of the departments concerned and of the Central Statistical Office, not only in the collection of prices, but also in deciding the form the indices have taken. The greatest burden of this work has fallen on Mr. B. B. Swan and his colleagues of the Board of Trade, who have had to meet the problems which are only indicated in this paper.

Composition of the New Basic Materials Index

<i>Commodity</i>	<i>Weight in New Index</i>	<i>February Price Relative Mid-1949 = 100</i>	<i>Weight in Existing Index</i>
Limestone and chalk	1.0	—	1.5
Stone and stone products	1.1	—	—
Clay, sand and ballast	1.3	—	1.5
Sulphur and pyrites	0.5	—	—
Iron ore	2.9	114	3.0
Iron scrap	1.0	—	—
Non-ferrous metal ores	3.1	—	—
Timber—Softwood	9.1	95	—
Hardwood	3.3	138	—
Plywood	0.9	85	—
Cotton, raw	12.7	235	6.0
Wool	11.5	—	12.0
Flax	1.8	200	—
Jute and jute products	2.7	—	3.0
Hemp	0.6	222	—
Sisal	0.6	220	3.0
Other raw and waste textile materials	0.9	—	6.0
Crude petroleum	3.7	149	—
Industrial petroleum products	0.7	—	—
Gums and waxes	0.9	—	—
Oils, fats and oilseeds other than mineral	5.2	104	3.0
Hides and skins	5.8	222	15.0
Wood pulp	7.8	165	18.0
Other paper-making materials	2.8	—	9.0
Rubber, raw	4.3	660	6.0
Phosphate rock	0.5	107	—
Tanning materials	0.4	—	—
Other miscellaneous materials, n.e.s.	1.8	—	—
Ferro-alloys	0.5	—	—
Aluminium ingots	1.3	138	1.5
Copper	5.6	172	3.0
Lead	1.7	166	—
Zinc	1.6	194	3.0
Other non-ferrous metals	0.4	—	4.5
Total	100.0		99.0

* "Machinery prices between the wars", *Bulletin of the Oxford University Institute of Statistics*, March, 1951.

DISCUSSION ON MR. STAFFORD'S PAPER

Professor R. G. D. ALLEN: Mr. Stafford's Paper is admirable in every respect and it is indeed with particular pleasure that I move this vote of thanks to him.

In the first place, Mr. Stafford's exposition is clear and economical. He has been short and concise, and at the same time he has raised, I think, all the important issues. His exposition is also economical in the more technical sense. Mr. Stafford is an economist and he has written as an economist. What he has written will be particularly appreciated and its significance particularly understood by economists. As regards his proposals which form the subject of the Paper, he has been bold in breaking with tradition, and I think he has based his proposals very firmly on what is both practicable and useful.

Let me take first the matter of the break with tradition in the form of the departure from the existing indices. I think Mr. Stafford must have felt rather like most of us do when we come to discard an old suit. The suit may have become threadbare with the passage of time, it may have ceased to be entirely fashionable, despite remodelling, and we may even realize that it was not particularly well cut at the outset. Perhaps Mr. Stafford has felt very much the same reluctance in giving up the old indices as in giving up an old suit. The existing index has been running for thirty years with one remodelling in the early 1930's, and the weights and other details have become inappropriate. Moreover, the index is based on a concept which is no longer fashionable in these post-Keynesian days, and some of us may think the original design was not altogether perfect. However, it served a good purpose and we are sorry it must go.

I agree generally with the changes that Mr. Stafford has adopted. In fact, I am on record in an article in the *Economic Journal* about two years ago in this sense. I agree that a general index purporting to measure in reciprocal the changes in the value of money is not, at least to economists, of any particular use. A general index is all very well as one column on a page of United Nations' statistics, along with similar indices for other countries, but I do not think that economists nowadays have much real use for an all-commodities index. I agree also with Mr. Stafford in concentrating, not on getting only those prices which are readily available, but on spreading the net wider and including a more representative collection of prices of final goods. I also agree with him in rejecting the use of the geometric mean in favour of the arithmetic mean. I think the arithmetic mean is more readily understood, and that it gives an index which relates to the aggregates that economists and others use nowadays.

Whilst on the matter of the geometric *versus* the arithmetic mean I would just mention one particular point. The geometric mean does facilitate the calculation of the index from month to month by a linking process, each month being linked to the previous month, and it does facilitate substituting one item for another, if necessary, in the process of linking. However, I think the ease with which this can be done has its dangers, and I will quote an example not very far removed from something that has happened in the past with this particular index of wholesale prices. One series in the index is rice. About 1940, rice disappeared from the market for obvious reasons and so, in substitution, the rice series was continued by using the price of semolina. Then, about 1946, rice came back; the price of rice was re-introduced into the index and semolina went out. Suppose that from 1940 to 1946 semolina doubled in price and rice coming back doubled in price from 1946 to the present, so that the index stood at 400 (1940 = 100). This, of course, ignores the relation of the price of rice in 1946 to the price in 1940. This might have been an increase of three times, so that it might be maintained that the proper index now is 100:600, and not 100:400. However, it may be maintained that all short run comparisons are correct. Even this is not strictly true because the contribution of the rice series to the whole index is different if it stands at 600 than if it is at 400. This is an indication of the ease with which things may go wrong if a geometric mean is adopted.

Mr. Stafford's proposals are to take particular families of price index numbers. Two of them relate to flows of commodities and to the corresponding money payments and receipts. In para. 16 it is said that the input series will be divided into home produced materials and imported materials. Equally, it is promised that the output series will be divided in suitable ways, distinguishing, for example, products for domestic use from those exported, and consumer goods from investment goods. An important point to the economist is the split between consumer goods and investment goods, and I cannot stress too much the importance of showing, despite the difficulty of getting the prices, separate index numbers for their categories and, in the investment goods index, the need for separating the products of the building industry from those of the engineering industry.

I should not be doing my duty if I were not at least mildly critical, but I have only one or two very small points as a result of hard searching through Mr. Stafford's Paper. They are perhaps sins of omission. I was disappointed to find little mention of fuel prices, apart from a reference

1951]

in para. 18 to the fact that the basic material index will exclude fuels, which are treated separately, I was wondering how Mr. Stafford was proposing to treat fuels—coal, gas, electricity and also petroleum products. I find, myself, certain difficulties in fitting these into any logical pattern of industrial input and output. Mr. Stafford's coverage is manufactures and civil engineering, omitting not only domestic agriculture and metal mining and quarrying but also coalmining. I should prefer to leave out gas and electricity production also. Coal, gas and electricity prices would not then appear in the output series, but they could appear as prices of inputs. Mr. Stafford's basic material index does not include them, but it would be possible to put alongside a corresponding index of prices of fuel, and I wonder what he proposes to do in that respect.

On the formulae used in the families of indices, I find para. 27 on the question of reversibility one of the few cases where I could not quite follow Mr. Stafford. He might possibly amplify this a little, though I do definitely agree with him in preferring the weighted arithmetic mean. The formula in paras. 31–34 was not mentioned in his summary to-night, but it will be noticed that the weight base is the average for the year 1948, whereas the comparison base is the middle of 1949. I should prefer to have the weight base and the comparison base the same, or, if different, to have the weights adjusted. However, I can see that there are difficulties, and perhaps this rather uncomfortable solution is all that can be recommended in practice. It cannot be far wrong because of the short interval between 1948 and the middle of 1949.

Finally, in para. 17, in the last sentence, and also in the *Board of Trade Journal* last week, I notice that it is said that the weight for wool in the old basic material index is smaller than in the new. I am not sure that that was one of the things that Mr. Stafford was trying to correct when he mentioned that the tables at the end of his Paper were subject to certain corrections, but it certainly seems wrong as stated in para. 17.

We shall all agree on the merits of this Paper. It is a model of its kind in the clarity of its thought and in its analysis and exposition. I can speak only for economists, but for them I would urge that this Paper is required. It is with great pleasure that I move the vote of thanks.

Mr. LEAK, in seconding: It is no mere formality to speak to a vote of thanks on a Paper of this kind. This is the first Paper that Mr. Stafford has read to this Society, and I am sure we all hope that we shall have many more of similar quality. Personally I found it most interesting. I am particularly glad that he has brought to the light of day the problems that beset those who have the day-to-day business of keeping an index running as well as those involved in its initial compilation. I feel sure that the extent to which the published figures may depend upon individual judgment as to the least objectionable course to follow when quotations falter or fail will be a revelation to most of those present.

I should like to say a few words about the rather interesting case of potatoes that Mr. Stafford mentions at the end of his Paper. I am not quite sure what he intends to do, but it seems clear that he is going to assign a different weighting for the old potatoes from that for the new potatoes, and I should like to know how he is going to calculate it. In the existing index we always eliminated commodities which are only on sale for a limited period, like sprouts or strawberries, and this is a real problem in connection with a new index. Is the weight to be that of the sales during the season only or during the whole year? I am not at all clear. When new potatoes come in, if they have got the weight for the year or even for the season, they are going to be hopelessly overweighted. There is a very definite change of quality from the old to the new potatoes when the latter come in, and in the existing index we made an allowance for that quality change. We also had a number of quotations for both old and new and permitted the new quotations to come in gradually so that there was no discontinuity, and we hoped that we had guessed more or less correctly the quantities coming on to the market at the various prices.

Mr. Stafford's new series of index numbers represent a very great advance. When the index was last revised, the material was just not available for us to do any such revision. I did make some little analysis of the figures that we had, but this was severely limited at the time by the information available.

To go back a little, the change made by Flux in 1921 was of rather fundamental importance. It might interest Fellows to know that Sir Alfred Flux wrote his Paper originally for the Royal Statistical Society, and it was only when it was submitted to the Secretary of the Board of Trade for approval in the normal course before being read that the Secretary said he wanted the index for the Board of Trade. Time does not permit me to go into the matter in detail, but I think that the difference between Fountain's and Flux's index was something of the same order of magnitude as that Mr. Stafford is now making.

I should like to say a word about the geometric and the arithmetic mean. Flux gave very good reasons, as I think, for preferring the geometric to the arithmetic, and for a general wholesale price index number I do not think there is any doubt about the advantages of the geometric

average. Mr. Stafford's series are not, of course, aimed at the same object. The geometric mean minimizes the effect of price divergencies from the average, or should we say, of wild shots at the target, but in this case we are not exactly aiming at one target, we are trying to get something which is different. I think I should probably still have preferred the geometric mean, notwithstanding the advantages that have been urged by Mr. Stafford, and also by Professor Allen.

There are two disadvantages about the arithmetic mean as I see it. The first is that you will have to change the weighting more frequently than with the geometric mean, and we had intended with the old series to revise it every five years. Secondly, and more important, we have the difficulty that when we have changed the base the relationship between prices in the one base year and the other will differ according to the base that we adopt, so that there cannot be a continuous series. That is illustrated by the volume index numbers. Fellows have probably seen when the index was recently revised that there was rather a marked discrepancy in the index in the volume of trade since the war as compared with 1938. That is the result largely of using the arithmetic average. Of course, the shorter the interval between the base years the less the discrepancy and the more continuous the series.

The construction of the index, as Mr. Stafford says, is not entirely satisfactory, but I agree with him that in the circumstances he mentions the middle of 1949 was the only practicable date for prices. I should myself have taken prices for a period of three months and averaged them rather than take the price quotations for June 30, as appears to be done in the series published in the *Board of Trade Journal*.

Mr. Stafford has divided the index number into two sections. I am glad to see from last week's issue of the *Board of Trade Journal* that it is proposed to continue to publish a combined index number. But I should really like to know how Mr. Stafford proposes to combine his two main sections, if it is not asking too much. I am also glad that he is proposing to publish the prices of individual commodities. In this he is resuming the practice that we followed before the war.

I have just a few words to say about the last table. Firstly, the conception of the new basic material index is different from that of the old. We have quotations for timber in the old index; we included timber as an intermediate product, because it was either sawn or planed, but, of course, it comes naturally into the new basic materials index, and I suggest that the table should include information about the weighting of timber in the 1930 index.

The other point is of more serious importance. It will be noticed that with the corrections which Mr. Stafford has made all the percentages in the last column are 3.0 or multiples thereof. These represent just one item in the old index, that is to say, they are the weighting at 1930 prices. The first column relates to the new index at 1948 prices. What I want to suggest to Mr. Stafford is that when this Paper is published in the *Journal* he should give us the percentage distribution of the old index, including timber, at 1948 prices, so that it can be directly compared with the figures in the first column. I suggest the inclusion of timber because the items which are included in the present basic materials index would otherwise automatically be overweighted.

In the second place, I should like to have a column giving the number of quotations in the existing index; this would give the 1930 weighting. Then it would be possible to see from these two columns how prices have changed differentially between 1930 and 1948. The year 1930, as Fellows probably know, was a very abnormal year for prices. Since then we have had the war and there are eighteen years between the two base years, so there are bound to have been great divergencies in price changes. It would be useful for the Society to have these changes on record.

I am very pleased that Mr. Stafford is finding it practicable to obtain prices of finished goods. I devoted some thought to this subject before I left the Board of Trade three years ago and I was rather appalled by the difficulties involved. I do not envy Mr. Swann his task of keeping the new series going on anything like a comparable basis, and I should like to wish both him and Mr. Stafford well in their new enterprise.

It gives me great pleasure formally to second the vote of thanks.

Mr. J. L. NICHOLSON said he would be quite brief, and would say only a few words from the point of view of the consumer who was concerned with the practical uses of any new set of indices. It was easier to agree on questions of method if we could first agree on the purposes which price indices could reasonably be expected to serve.

One obvious need was for a set of price indicators for individual commodities for which there were markets in this country. These did not involve any very difficult theoretical problems. It was when we came to consider grouping different commodities together that the real problems arose. We ought to be certain that the groups as such were of some interest to an economist. Data were required for studying the economic circumstances of different industries. For instance, we would want to be able to find out how much of the change in the total value of output of an

1951]

industry was due to a change in price and how much to a change in quantity; and to do the same thing for materials, fuel and other components of cost. For these purposes, it was necessary to have price indices for products grouped by industries.

It was also important to have price indices for certain broad economic categories, such as investment goods, consumption goods, exports. In general, the indices should correspond to categories which were of interest in themselves; and it should be possible at least to conceive of corresponding money value figures.

The decision to follow an industrial classification provided a clue to the correct solution of the problems of weighting, and of the particular stages at which prices were required. On the output side, for instance, goods should be priced at the stage at which they left the industry: output prices should, in other words, include all work that was done within the industry, and should exclude any additions to the value of the goods after they left the industry. In practice these prices would always be gross prices, in the sense of including the value of all work done up to that stage. The output prices of different commodities should therefore be given weights proportional to the gross values of output. Similarly, on the input side, prices were required at the stage at which the materials, etc., entered the industry, including the value of all work done up to that point. Different constituents of input should be given weights proportional to the payments made by the industry in question.

The beauty of this method was that it could be applied to an industry, to a section of industry, or to a group of industries. It avoided all the complicated problems of double-counting, overlapping, etc., which had been so troublesome in the past. We could draw a ring round an industry, or group of industries, exactly where we pleased; and then all we had to do was to observe the prices and values of different materials, etc., as they entered the ring, and of different products as they left the ring. We were not concerned with what happened inside the ring.

The considerations which had determined the form of the new indices were severely practical and realistic. Each index would, so far as practically possible, have a clear and definite connotation. He would even be prepared to say that an index number should, in theory at least, provide an answer to a specific question, e.g., how much had the cost of a given bundle of goods changed between certain dates? Mr. Stafford had discussed the weaknesses of the existing Wholesale Price Index and had explained why it failed to satisfy this test. The arguments against an index which embraced all goods at all stages of production, and which could therefore be affected by the degree of integration of industry, applied with equal force to a general index of all intermediate products. If all technical processes of production were neatly divided into three stages, and if there were no communication between different lines of production, there might be advantages in having price indices for each stage. But when some raw materials (e.g., coal) were used at almost all stages of production, when there were many others which each formed part of a very large number of final products, when the "final" product of one industry might be used in the production of the raw materials or "intermediate" products of another, or even of the same industry, there was little to be said, in such circumstances, for a general index of all intermediate products. It was not clear what question it was intended to answer; and even if the question could be formulated, it was very doubtful whether the answer could be obtained.

He joined in welcoming this preview of the Board of Trade's work, of which a fuller account would doubtless become available when the work was completed.

Mr. STONE said that it gave him great pleasure to add his hearty congratulations to those of other speakers on the excellent paper that Mr. Stafford had given to the Society. He was glad that the Board of Trade had got away from the idea that a wholesale price index should provide a measure of changes in the value of money, and was proposing to concentrate on the idea of attempting to deflate economically interesting aggregates of transactions involving goods and services. He wished to offer a few remarks on the generalization of this approach from the standpoint of social accounting, and to emphasize the close relationship between the kind of price indices that Mr. Stafford had described and the corresponding indices of production. He fully realized that a complete programme on the lines he would discuss could not be undertaken all at once, but he thought that the general point of view might be worth keeping in mind as the work of the Board of Trade in this field progressed and as more information became available from post-war censuses of production. It would be seen that his comments followed certain strands of thought in the remarks of the previous speaker, Mr. Nicholson.

His point of departure was to consider for a closed economy, without government, a goods and services matrix, denoted by $[v_{ij}]$ where $v_{ij} \equiv q_{ij}p_i$. Here the symbols v , p and q denoted respectively the values transacted and the accompanying prices and quantities between two accounts denoted by i and j , $i, j = 1, 2, \dots, n$. The accounts could relate to various things such as products, processes or purposes, but he preferred to think of them as relating in the main

to industries. Thus the k^{th} row and column of the matrix would contain respectively the sales proceeds of the k^{th} industry and the operating outgoings of that industry. In addition there was a certain subset of accounts, denoted collectively by h , which related to final consumers and to capital transactions.

If attention was concentrated on the account for industry k and if two periods, 0 and 1 say, were considered, then

$$\frac{\sum_j q^1_{kj} p^1_k}{\sum_j q^1_{kj} p^0_k}$$

would represent a price index of the gross output of industry k with weights appropriate to year 1. In this expression the symbols p and q must be taken to represent the collections of goods and services produced by industry k , but he thought that no confusion would arise from omitting this additional summation both here and subsequently.

In a similar way the corresponding price index of the input into industry k could be written

$$\frac{\sum_{i \neq h} q^1_{ik} p^1_i}{\sum_{i \neq h} q^1_{ik} p^0_i}$$

These expressions could be combined to give a price index of a unit of net output which could be written

$$\frac{\sum_j q^1_{kj} p^1_k - \sum_{i \neq h} q^1_{ik} p^1_i}{\sum_j q^1_{kj} p^0_k - \sum_{i \neq h} q^1_{ik} p^0_i} = P_k, \text{ say.}$$

The symbol P_k was used to suggest a Paasche index. A Laspeyres price index of a unit of net output of the industry might be denoted by L_k , while the corresponding production indices showing changes in the quantity of net output might be denoted by Π_k and Λ_k . Thus

$$\Lambda_k = \frac{\sum_j q^1_{kj} p^0_k - \sum_{i \neq h} q^1_{ik} p^0_i}{\sum_j q^0_{kj} p^0_k - \sum_{i \neq h} q^0_{ik} p^0_i},$$

so that as usual $P_k \Lambda_k = \Pi_k L_k = V_k$, where V_k was the change in the value of the net output of industry k over the period.

Each of the indices related to a single industry. If the numerators and denominators of these indices were summed over $k \neq h$ then four aggregate indices would be obtained, P, L, Π, Λ say, which would relate to the domestic product as a whole. Just which product concept they would refer to would depend on how h was defined, but most conveniently it would be the gross domestic product at market prices.

Thus once one started to deflate aggregates of good and services that represented the inputs of groups of transactors, in this case industries, the individual index numbers bore a simple relationship to the corresponding net output index numbers, and furthermore summed to a meaningful overall index, namely, the price index of the total domestic product. Furthermore, instead of aggregating net indices over industries it was possible to reach identical aggregates by summing gross indices over final users. Thus—

$$\Lambda = \frac{\sum_{k \neq h} \left(\sum_j q^1_{kj} p^0_k - \sum_{i \neq h} q^0_{ik} p^0_i \right)}{\sum_{k \neq h} \left(\sum_j q^0_{kj} p^0_k - \sum_{i \neq h} q^0_{ik} p^0_i \right)} \equiv \frac{\sum_{i \neq h} q^1_{ih} p^0_i}{\sum_{i \neq h} q^0_{ih} p^0_i}$$

Mr. VIBART said that he did not propose to attempt anything technical or learned, but he could not refrain from expressing his admiration for the humanity which the author had succeeded in injecting into this subject. He thought that the characteristic which exponents of index numbers had not been successful in was this particular one of bringing a human element into the picture. The author almost made the compilation of index numbers seem exciting, and it was a very important thing that the public should feel not alone that index numbers were intricate mathematical creations, but that they were constructed after overcoming day-to-day difficulties and were built up for a human purpose and that they could help to solve human problems.

Of course, this forest of indices forecast by the reader of the paper was rather alarming, and did suggest increased possibilities of misunderstanding and misquotation.

He wondered whether Mr. Stafford might not find it possible to infuse into the *Board of Trade Journal* some of the human attitude to be found in this paper.

He added his appreciation of the author's outlook as exemplified on p. 456, where he says that the inclusion of highly fabricated goods does not create the troubles and difficulties but "simply makes the statisticians face them."

1951]

Professor RICHARDSON said that he welcomed the publication of families of index numbers and also the individual price changes of the various commodities. These would be valuable for economic research and practical industrial purposes. Some uneasiness had been expressed by one or two speakers about the use of an arithmetic mean instead of a geometric mean, and it would be interesting if the author could make available to Fellows of the Society a comparison of the results by the two methods. He understood that there would be series covering final products and consumer goods, and he wondered whether in such series a distinction would be made between utility goods and non-utility goods; the latter were much higher in price, which included purchase tax if bought for home consumption, but were largely exported.

Mr. FRIDAY had two points to discuss. The first was a question of policy and the second of statistics. The proposals which the author had made included an index of all articles in the final stage of production or consumption, i.e., an index which measured the changing value of money in the hands of retailers and investors. There was little reason to suppose that there would be any great divergence between the movements of a wholesale price index of personal consumer goods and a retail price index of those same goods. He felt that logically, and as a matter of convenience, the Board of Trade should go one stage further and produce the retail price index for the country. The word "wholesale" could be dropped and we should have a family of index numbers of prices at various stages. The Ministry of Labour compiled the index largely for historical purposes, and the author's proposals were so complete a breakaway from the past that there was surely much to be said for making yet another break at the same time.

His second point concerned the measurement of changes in the prices of durable goods. He was glad that the author had discussed at some length and, indeed, so clearly the problem of changes in the specification of goods. This was a very difficult problem confronting statisticians when they expanded an index to include representative items of all articles manufactured and consumed in a modern economy, but he thought that the difficulty was often exaggerated. As the author rightly stressed, the problem was by no means new; it had merely assumed greater significance in the proposed index numbers. One of the objections raised in the past to the inclusion of many things at the "end" stage of production had been this difficulty of measuring movements in the prices of changing durable goods, but, as Mr. Leak had pointed out, those who had not worked on the compilation of index numbers would be surprised if they saw the extent to which judgment had always to be exercised in the choice of prices of goods included. The fact he would stress was that the problem was really only difficult at the point when a new model took the place of an old one. In a developing industrial economy new products were always taking the place of old ones and statisticians could not price old models for any length of time. At the point of substitution a statistician had to decide whether the price of the new model reflected any change in price or quality or both and what the change amounted to, but the problem was only serious in new and rapidly developing industries—e.g., radio in the late twenties and early thirties and television now. After a while, really fundamental changes were few and different prices for new models compared with old represented more often than not, fairly unimportant changes in design and taste which could be taken care of by an examination of costs. Between the dates of substitution the measurement of price changes presented no real problem at all.

Mr. STAFFORD subsequently replied in writing as follows:

Professor Allen's reference to the difficulty which arises from the substitution of one commodity for another (semolina for rice in his example) by linking month to month changes in a geometric mean index, underlines the care which must be exercised in finding a solution to similar problems in maintaining the new indices. A price quotation may become unsatisfactory for a variety of reasons—it may reflect a controlled price at which business cannot be done or an uncontrolled price in a controlled field and represent terms for marginal transactions; or the commodity may disappear or become unimportant for technical reasons; or the source of information may no longer be available. In general, it will be desirable to substitute another series and, broadly, two methods of substitution are open. First, for the new commodity the price relative between the current and the base period may be introduced. This will create a discontinuity between the recent past and the present, unless the index can be and is revised over a past period—say for a year back—whereby the discontinuity is pushed back in time. Even if revision can be made, this course has its disadvantages: users of the index may be embarrassed by extensive backward revision; extra work is involved; and discontinuities cannot be avoided. Secondly, the two price series can be linked together, after the manner described by Professor Allen, to create a constructive series relative to the base year. This has the advantage of avoiding discontinuity or revision, but creates a very serious obstacle towards the reinstitution of the old series if it becomes

available once more. And, of course, the practice introduces a highly artificial price series into the index. Neither device is wholly satisfactory; each may on occasion be the more appropriate.

The treatment of fuel prices is unduly brief, as Professor Allen rightly observed. We have thought it best to exclude gas and electricity production and distribution from our complex of industries for which a price index for both input and output is to be calculated. This is a fairly arbitrary decision which can, perhaps, best be defended on the grounds of unwillingness to extend the indices to cover services. However, petroleum refining and the coke oven trade will be included and in indices reflecting price changes of consumer goods, gas and electricity (as well as coal and home-grown and imported foods) will be given appropriate weights.

It is proposed to produce an index of prices of fuel used by manufacturing industries which will complement the index for basic materials, and a total input index can be prepared or will be calculable by the user on the basis of published weights. Input indices so far calculated for separate industries have not covered fuels, in part because the new series of fuel prices were not available. For some industries, however, it will clearly be unsatisfactory to exclude fuels, whose cost is so important an element in total input, or to rely upon a fuel index appropriate to industry in general. Convenience may, therefore, best be served by some asymmetry in the composition of the sectional input indices.

In para. 27 I explained that considerable importance was attached to the quality of time reversibility (in Irving Fisher's sense) and that as a result the old index was constructed as a simple geometric mean index. The movements indicated by this index are, of course, unaffected by the basis of reference; and the index being ostensibly unweighted (the weighting being built into the index through the choice and number of price relatives incorporated) the index fully satisfies Irving Fisher's test of time reversibility, i.e., the transposition of suffixes in the formula of calculation gives the reciprocal of the "time antithesis" of the index. (The weighted geometric mean index does not satisfy this test.)

The arithmetic mean index is not reversible in this Fisherine sense, because, of course, the transposition of suffixes not only alters the basis of reference but also alters the weighting system. (The simple aggregative index is spuriously reversible in this sense because the weighting is implicit.) But the arithmetic mean index can, of course, be reversible if only the basis of reference and not the weights are changed. The advantages of the geometric mean index for this purpose have, therefore, tended to be overstressed and a rather false emphasis has been placed on the difference in behaviour between the geometric and arithmetic mean indices.

Mr. Leak requested more information on the method to be adopted for treating such seasonal commodities as new and old potatoes. One method which I indicated is to treat new and old potatoes as separate commodities and to give each its (seasonal) weight. This method introduces some discontinuity into the index, and is subject to other disadvantages, e.g., quality differences in new potatoes are not allowed for. I was not suggesting that this was the method finally to be adopted. In fact, every method of dealing with this problem has disadvantages—that suggested by Mr. Leak is arbitrary in the determination of rates of substitution between new and old potatoes. Nor is the important deterioration in quality of old potatoes allowed for. I agree that so far as possible it is wiser to exclude these seasonal commodities from the index; when they must be included we will look very carefully at the different methods which can be adopted.

I am unable completely to agree with Mr. Leak in his opinion that an arithmetic mean index should have its base changed more frequently than a geometric mean index.

A base weighted arithmetic mean price index is said, in general, to have an upward bias because for prices that move up or down more than the average of prices the weights tend to become too great or too small respectively in relation to current consumption. But this will not be invariably so. If differential price movements reflect autonomous changes in technical factors which are altering production functions or cost conditions, then this kind of bias is likely to be present. But changes in price may also be the consequence of changes in demand or changes in expectations of future price movements. A rise in price may be associated with an increase in consumption and a fall with a decrease. Just how much bias compared with its currently weighted counterpart will be revealed by the base weighted index will depend on the economic history of the period it covers between revisions. Compared against the performances of the currently weighted arithmetic mean index the base weighted geometric mean may or may not give "better" results than the base weighted arithmetic mean index. But in any case is this a correct criterion? Should the need for reweighting be determined by the behaviour of the two base weighted indices against their respective current weighted counterparts? If this is so, and if we are making our text the percentage deviations of the two families of index numbers, then I do not think it is necessarily the case that the arithmetic mean index will need more careful control. And even if the geometric mean index offered some advantage, this as I attempted to explain, is bought at the cost of economic meaning in the index.

1951]

Mr. Leak is surely mistaken in ascribing the dilemma of twin relationship between base years on a change of base to an arithmetic mean index. The dual relation arises from the change in weights and not from the method of averaging.

At the moment there are no plans for integrating the various indices in the new series into an all articles index. It is difficult, if not impossible to conceive of a meaningful and practicable system of weighting for such an index, and further thought must be given to this problem, if, despite all that can be said against it, such a comprehensive index is wanted.

The purpose of the second table was to indicate the difference in weighting of the old and new basic materials indices. The weighting of the old index reflected prices and quantities in 1930 and, of course, if 1948 prices were substituted for 1930 prices the weights would be different; but I do not believe that the labour involved would be justified by the creation of this set of imaginary weights; and I think the inclusion of sawn and planed timber in the weighting system set down would be misleading as these commodities were represented in the intermediate products index and not among basic materials.

I agree entirely with Mr. Nicholson's scepticism on the value of an intermediate products index. I think it has no permanent place in this family. My remarks were intended only to suggest that in the absence of an output index for the complex of manufacturing industries, which may yet take some time to complete, an intermediate products index might serve the purpose of underlining the fact that the prices of manufactures are much less volatile than those of basic materials.

Mr. Stone has indicated a good deal of interesting ground for us to cover but perhaps two doubts should be expressed. First, that there is a considerable danger in preparing output and input indices for narrow bands of industry, because errors in weighting and sampling may lead to very misleading conclusions being drawn from the relative movements of the two sets of indices, and the index numbers for net output might behave very badly. Secondly, that more consideration should be given to the economic meaning of the index numbers of prices and quantities of net outputs to which Mr. Stone refers.

I do not think it is practicable as Professor Richardson suggests to prepare an arithmetic mean index for the past using data entering into the old geometric mean index. Moreover I do not believe that decisive conclusions can be drawn from the relative behaviour of the two types of indices; the choice between them should be guided by the kind of concept which is to be elucidated.

Both utility and non-utility goods will be included in the indices of output and consumer goods prices, but in general it is not proposed to prepare separate indices for the two categories.

I am very glad to have the support of Mr. Friday's considerable experience for our belief that the problems we have set ourselves in incorporating highly-finished goods in our indices are not insuperable ones.

As a result of the ballot taken during the meeting the candidates named below were elected Fellows of the Society:

Alexander Barr.
Sydney Alfred Beach.
John Farrant Bunford.
Jack George Cotterill.
John Stanley Downham.
Dennis Albert Evans.
Reginald Wilfred Farmer.
Frederick Philip Glass.
John Henry Gunlake.

Alan Hollidge Green.
Frank Edwin Haynes.
John Michael Meath Hill.
Geoffrey John Knapman.
Harold Livesey.
Alastair Gordon MacDougall.
William Mabane.
Inder Mohan Sahni.
Arthur Allman Skinner.

THE SOURCES AND NATURE OF STATISTICAL INFORMATION IN SPECIAL FIELDS OF STATISTICS

UNITED KINGDOM PUBLISHING STATISTICS

By MARJORIE DEANE

Introduction

1. STATISTICS about publishing are far from comprehensive. This is not surprising, if only because of the almost overwhelming variability of the products of the trade. While published material can be classified broadly into books, newspapers or periodicals, what an assortment there is within each group! The small paper-backed pamphlet selling at a shilling ranks as a book in the same way as the leather-bound encyclopaedic tome. Newspapers range from the daily nationals with their gigantic circulations to the local weekly editions of small parishes. And a periodical almost defies description. Indeed, there are no definitions which prescribe rigid boundaries to the three categories.

2. If the statistician could collect together all he would like to know about publishing, his task of analysis would be a difficult one. But any attempt is made much harder by the fact that publishing is a highly competitive trade unsympathetic towards statistical probing. This is particularly true of the book-publishing trade, which contains a large number of individualistic firms who jealously guard their particular corners. Some statistics (the aggregate figures of turnover) have become available in recent years only because of the necessity for publishers to make a joint appeal to the Board of Trade for paper supplies during the last war.

3. The varied nature of the book trade—and of publishing as a whole—makes it dangerous to generalize from the experiences of the few publishing firms who have revealed some details at one time or another. Attention will, nevertheless, be drawn in this paper to certain observations of individual publishers, simply because the information in some fields is so limited that any pointers may be helpful. It would be tedious to keep repeating the warning against generalization, but it should be borne in mind throughout.

4. Most of the available information about publishing comes from non-Government sources. Official statistics cover employment, paper consumption, consumers' expenditure on reading matter and those provided by the census of production. Government expenditure on producing its own publications is entered under the vote of the Stationery Office and the Civil Estimates give a breakdown by departments. But the main recurring statistics are collected by non-Government bodies from publishers. The Royal Commission on the Press provided a good deal of new statistical matter on newspapers and periodicals (ref. 22). Being more comprehensive and more up-to-date, the Report of the Royal Commission has largely replaced the hitherto standard reference book on the press prepared by PEP (ref. 19). Some other special inquiries have been undertaken by private investigators. It has seemed appropriate to mention a few readership surveys of a general nature and to indicate what statistics are available about libraries.

5. The material does not fall easily into watertight compartments. But, with a certain amount of cross-reference, it has been divided into six sections:

Supplies of Books.

Supplies of Newspapers and Periodicals.

Census of Production, Employment and Paper Statistics.

Finances of Publishing.

Consumer Expenditure on Reading Matter.

Library Statistics and Readership Surveys.

Some very brief historical notes have been included at the ends of the first two sections. References throughout are to the short list of sources of information at the end of the paper.

1951]

Although the text may refer only to a particular section of the books listed, this is not indicated, since they are all concerned only with matters related to publishing and may be of general interest throughout. Where the same publication is referred to several times, reference to its full title is usually only given the first time.

In the tables the sums of individual items do not necessarily agree exactly with the totals because of rounding.

Supplies of Books

Value of Turnover and Exports

6. A measure of the activity of book publishers is provided by their own trade association. Every three months the Publishers' Association receives from its chartered accountants the aggregate turnover (and that part of it which is export trade) not only of its members but also of other publishers in the Book Publishing Export Group and of the Book Clubs. These statistics are considered by the Association to be virtually representative of the whole trade. Numerically, the members of the Publishers' Association represent a small minority, being only about 350 out of some 1,700 firms included in Whitaker's list of publishers (given in their book lists (ref. 8)), but these 350 members are reckoned to cover about 90 per cent. of the trade's total turnover. Including the other members of the Book Publishing Export Group—about 150 firms—the Association believes that something like 98 or 99 per cent. of the probable total turnover is covered. The other 1,200 or so publishers listed by Whitakers, whose figures are not collected by the Publishers' Association, are reported to be in a very small way of business so far as book publishing is concerned.

7. The statistics provided by the Publishers' Association give no information about the turnover of individual publishers. The only sub-division—apart from the differentiation between total and export trade—arises from the method of compilation as follows:

Combined figures for book publishers and book clubs are given for both total turnover and exports. On the export side two additions are then made. One is for the service charge of wholesale export booksellers to cover such matters as the looking-out of books and the tracing of improperly ordered ones. The service charge is reckoned according to the turnover of the wholesale export booksellers; the wholesale price of the books has been already included in the figures provided by publishers. The further addition to exports is for the overseas sales of retail export booksellers. Altogether returns are received by the Publishers' Association from something of the order of 500 publishers, and about a dozen wholesale exporters (such as Simpkin Marshall, W. H. Smith and William Dawson) and about a dozen retail export booksellers (such as Basil Blackwell and J. E. Bumpus). Prices throughout include carriage and are on a wholesale basis with the exception of the exports of retail export booksellers which include the retailer's margin. (There is no purchase tax on printed books except on some children's books, such as those used for painting, cutting-out and transfers.)

TABLE 1
Value of Turnover of Book Publishers and Total Receipts from Exports

Year	Total Turnover (£ thousand)	Receipts from Exports (£ thousand)	Receipts from Exports as Percentage of Total Turnover
1937	10,507	3,146	30.0
1938	10,706	3,171	
1939	10,322	3,155	
1940	9,953	3,517	35.3
1941	13,987	3,984	28.5
1942	16,736	3,609	21.6
1943	19,291	4,470	23.2
1944	20,501	4,895	23.9
1945	21,980	5,139	23.4
1946	26,962	6,715	24.9
1947	30,204	7,413	24.5
1948	33,241	8,739	26.3
1949	34,297	9,799	28.6
1950	37,159	11,394	30.7

8. Yearly statistics on the above basis date back to 1937 and are reproduced in Table 1. The figures are now computed quarterly and are circulated to members of the Association. They are also reproduced at intervals in *The Bookseller* and other trade journals and are sometimes commented on in the Press.

9. It would probably be straining the figures in Table 1 too far to say that they provide an exact comparison between the turnover of to-day and that of ten or more years ago. Some doubt must remain about whether the coverage of the statistics has been consistent enough over such a length of time. But the trend and general extent of the growth in turnover is well established by the figures. A few further points should perhaps be mentioned about the statistics. They do not set out to measure the current production of British books, and no accurate assessment of this is possible. For one thing, there are no estimates of changes in publishers' stocks. Further, any sales by publishers of imported books will be included in the total turnover and, although these will not be a large proportion of the whole, they certainly cannot be ignored, yet cannot be measured accurately (see paragraph 14). In the case of British publishers who act as sole agents for certain American publications (such as the Oxford and Cambridge University Presses), the influence of imported books on turnover may possibly be quite appreciable.

10. The headings in Table 1 have been worded rather carefully to take in the fact that the export figures include certain amounts which are not a part of the publishers' total turnover. For instance, in the third quarter of 1950 the total turnover recorded by the Publishers' Association for publishers and book clubs was £9,774,284, of which £2,811,112 was for overseas sales. But added to the export figure was £65,538 for the service charge of wholesale export booksellers (whose turnover was £601,141) and £185,645 for exports by retail booksellers—and of this latter figure the retailers' margin and their carriage charge would not be included in the publishers' turnover. While this makes the export proportion of turnover a little larger than it should be on a strictly comparative basis, a certain amount of export trade by retail booksellers must escape the net of the Publishers' Association, although it is believed to be only small.

11. The turnover figures are, of course, at current prices. The only general guide to the change in the prices of books comes from the consumer price index published in the National Income White Paper (see paragraph 60). In 1950 the retail price index of books was about 52 per cent. above the 1938 level. Using this as a rough means to deflate the 1950 value of turnover, the volume of turnover had rather more than doubled since pre-war.

Details About Exports

12. There is an important difference between the export figures as compiled by the Publishers' Association and the official ones published in the Trade and Navigation Accounts of the United Kingdom; the former include those books sent by post and the costs of carriage throughout, while the latter do not. On both scores the Publishers' Association's figures would be expected to be larger. And, because a considerable number of books can only economically be exported by post, it would not be surprising if the difference were quite appreciable. It is only possible to make a fair comparison from 1948 onwards. Before then the Trade Accounts only gave figures for a whole group labelled "Books, printed, and other printed matter for reading purposes (other than music) and manuscripts and typescripts". It is only since 1948 that printed books have been given separately. In 1948 book exports, according to the Trade Accounts, amounted to £3,593,783, against £8,739,236 recorded by the Publishers' Association; in 1949 the figures were £3,963,685 and £9,798,838, and in 1950 they were £4,834,757 and £11,394,220 respectively.

13. The monthly Trade Accounts do not give details of countries to which books—as opposed to the general class of printed matter—are exported. The Annual Statements of the Trade of the United Kingdom do, however, show the complete analysis—again from 1948 onwards only. The Publishers' Association makes an analysis of destination of exports based on a sample survey covering usually about half the total turnover. Unfortunately, however, this analysis is not made available for publication, but only for the private information of the members of the Association. But 1947 figures have somehow appeared; they were reproduced in *The Bookseller*, and in *Records and Statistics*—the supplement to *The Economist*—on July 10th, 1948. Since the Trade Accounts do not give the breakdown for 1947, it is impossible to assess the comparability, even on a proportional basis, between the two sets of figures. For what they are worth, some per-

1951]

centages for recent years derived from the Annual Statements of Trade (those for 1949 and 1950 being specially provided by the Customs and Excise prior to publication of the full statements) are given in Table 2, compared with the 1947 analysis of the Publishers' Association.

TABLE 2
U.K. Exports of Printed Books to Main Overseas Buyers
(Percentages of Total Value*)

Importing Country	From Survey of Publishers' Association	From Trade Accounts		
	1947	1948	1949	1950
Australia	18.1	19.4	20.7	20.9
South Africa	14.5	7.8	6.3	5.0
United States	12.5	18.5	19.4	23.0
India	8.3	5.6	—†	—†
New Zealand	6.5	6.5	7.7	8.0
Canada	5.1	6.7	7.0	7.4
Ireland	3.9	5.1	5.2	4.3

* Based on total value as recorded by Publishers' Association for 1947 and as recorded in Trade Accounts for 1948 onwards.

† Not available at time of writing.

Imports

14. The only figures are those provided by the official Trade Accounts and, as with the exports, they are not comprehensive, since they exclude books received by post. Also, as with exports, analysis by countries is only available in the Annual Statements of Trade. Out of a total of £2,129,853 in 1948, £1,007,806 was for books imported from the United States; £126,371 of the total was re-exported. In 1950 the recorded imports of books totalled £1,790,824.

Titles Published Annually

15. A weekly list of books which have been published or re-issued in the British Isles is compiled by *The Bookseller* (ref. 3) and reproduced in each issue. Each book is entered alphabetically under both author and title (and, where necessary, subject). The price is recorded, and also whether the book is a new title, a revised edition, a cheap edition, or merely a reprint. A list is also published in cumulative form monthly in *The Bookseller*. At quarterly intervals Whitakers (who are the publishers of *The Bookseller*) publish a cumulative list with a section classified according to subject. These lists date from the beginning of the calendar year, the one for January to March being available in May, for January to June in August, for January to September in November—and the annual volume is published in February (ref. 8).

16. *The Bookseller* obtains its information through two main channels. It supplies publishers with special cards on which they report the particulars of their forthcoming books. Further, the particulars of every book subscribed to at W. H. Smith are sent to *The Bookseller*. This provides a double check, and is specially useful in picking up the names of any new publishers. In addition, *The Bookseller* also subscribes to press cuttings of book reviews in the provincial press, whereby books of purely local interest have been tracked down which would otherwise have escaped notice. By these means *The Bookseller* reckons that the figures which they compile of issues of new books are now very comprehensive—to within 98 or 99 per cent. of the total of books of all descriptions. (In compiling its totals *The Bookseller* omits books and pamphlets priced at less than 6d. and also Government publications, except the more important issued by the Stationery Office.) The accuracy of the figures has been much greater in the last five years than ever before. This should be borne in mind when looking at the figures of Table 3, which are taken back to 1937. It seems likely that before 1946 the figures underestimated the true position. *The Bookseller* distinguishes one further class not shown in Table 3—the “editions-de-luxe”. These have averaged about 40 a year in the post-war period, compared with about 80 a year in 1937 to 1939.

TABLE 3

Number of Book Titles Published Annually

<i>Year</i>	<i>Reprints and New Editions</i>	<i>Translations</i>	<i>Total (including new titles)</i>	<i>Reprints and New Editions as Percentage of Total</i>
1937	5,810	434	17,137	33.9
1938	5,307	365	16,219	32.7
1939	4,493	305	14,904	30.1
1940	3,530	168	11,053	31.9
1941	2,326	131	7,581	30.7
1942	1,499	109	7,241	20.7
1943	1,201	129	6,705	17.9
1944	889	101	6,781	13.1
1945	921	127	6,747	13.7
1946	1,508	174	11,411	13.2
1947	2,441	257	13,046	18.7
1948	3,924	308	14,686	26.7
1949	5,110	463	17,034	30.0
1950	5,334	466	17,072	31.2

17. *The Bookseller*, which started publication in 1858, has collected annual figures of issues of new books for some considerable time. I have not traced them back to their starting-point, but they were certainly available before the First World War. In 1913, 12,000 titles (including new editions and reprints, etc.) are recorded. By 1918 the number had fallen to 7,000, rising to 12,690 in 1924. To date, the 1937 number of 17,137 titles holds the record. There is no doubt, however, that no statistical precision should be attached to these figures going far back, and they must be taken only as a rough guide to trends. As already stated in the previous paragraph, it is only since the end of the last war that a good degree of accuracy is claimed for these compilations.

18. It is particularly important to stress that the number of titles issued is no indication of the volume of output of the book trade, since it does not tell us how many copies of each book were published. Thus, the hundred thousand or so copies printed of a best-seller are not distinguished from the few hundred of a book of limited interest. It would be most misleading to use the trend of the number of titles published as an indication of the prosperity or otherwise of the book trade. More new books were being published in the 1930's than ever before, but they were bad years for the book trade, and ones in which several well-known publishers went out of business. It was a time of over-production. In the last war demand for books was high, as the figures for turnover have shown, although publishers were producing relatively few new titles. The volume of turnover in 1950 was probably at least twice that of 1937 (see paragraph 11), while the number of titles published was about equal. In other words, the same output of fresh material commanded much bigger sales in 1950 than in 1937.

19. What can be gathered about the number of copies printed of any one title? Some very crude arithmetic can give a guide to the average number. In 1950 the total retail price of all books published in the year (1 copy of each) was £9,793. The total turnover of publishers was £37,158,652. Turnover is not a measure of publishers' sales from new production, but for the purposes of this very rough calculation, and taking into account that turnover has followed a fairly consistent trend in recent years, production has been assumed to be at about the same level. To compare with retail prices an addition must be made for the trader's discount. Publishers give different discounts according to the type of book and quantity ordered. Educational books, for instance, carry a smaller discount than works of fiction, and may even be sold direct from publisher to educational authorities. Libraries do not usually buy direct from publishers, but can obtain a 10 per cent. discount from booksellers licensed to give it. In general, a figure of about 33½ per cent. discount is quoted as an average, but if applied to the home market it is probably too large. Books sold for export, however, particularly fiction, carry a higher rate of discount than is received by the home bookseller. British publishers often produce special colonial or overseas editions on which a discount of 50 per cent. is allowed. 33½ per cent. is probably too small for the export market. It might seem that about 30 per cent. is the most appropriate figure to use for home and export markets together. If we rate up the total turnover by that percentage and divide by

1951]

£9,793 we could say that the average number of copies published of each title in 1950 was of the order of 5,000. This very rough calculation is open to a number of objections, including the disregard of imports, but its only purpose is to provide the order of yardstick with which to measure the figures of some of the big editions of popular books, such as the first edition of Mr. Churchill's war memoirs, *The Gathering Storm*, which was said to be 220,000 copies, and *Their Finest Hour*, which numbered 276,000.

Book Subjects

20. *The Bookseller* analyses the titles published according to subject matter divided into 43 groups. The classification is done by the publishers when returning particulars of new books. The analysis is published monthly and is given cumulatively throughout a year. Some annual figures for the main groups are reproduced in Table 4; all books published in each year, whether new titles or new editions, are included.

TABLE 4
Classification of Book Titles, New and Republished

Subject	1937		1939		1949		1950	
	Number	Percent- age of Total	Number	Percent- age of Total	Number	Percent- age of Total	Number	Percent- age of Total
Art and architecture	230	1.3	193	1.3	547	3.2	494	2.9
Biography	789	4.6	689	4.6	581	3.4	522	3.1
Botany and agriculture	178	1.0	200	1.3	311	1.8	252	1.5
Chemistry and physics	133	0.8	120	0.8	221	1.3	184	1.1
Children's books	1,597	9.3	1,303	8.7	1,656	9.7	1,543	9.0
Educational	1,337	7.8	1,350	9.1	1,246	7.3	1,370	8.0
Engineering	155	0.9	168	1.1	289	1.7	286	1.7
Fiction	5,097	29.7	4,222	28.3	3,596	21.1	3,697	21.7
Law	248	1.4	224	1.5	406	2.4	320	1.9
Medical and surgical	543	3.2	498	3.3	603	3.5	614	3.6
Natural history	186	1.1	165	1.1	250	1.5	276	1.6
Poetry and drama	569	3.3	535	3.6	554	3.3	695	4.1
Politics	633	3.7	704	4.7	546	3.2	710	4.2
Religion	927	5.4	763	5.1	967	5.7	971	5.7
Sociology	264	1.5	200	1.3	398	2.3	254	1.5
Sports and pastimes	260	1.5	156	1.0	574	3.4	451	2.6
Technical handbooks	322	1.9	228	1.5	685	4.0	648	3.8
Topography	139	0.8	76	0.5	282	1.7	407	2.4
Travel and adventure	411	2.4	311	2.1	159	0.9	134	0.8
Others	3,119	18.2	2,799	18.8	3,163	18.6	3,244	19.0
Total	17,137	100.0	14,904	100.0	17,034	100.0	17,072	100.0

21. It is easy to criticize almost any classification of books by subject. The one just described is only intended as a rough and ready indicator catering for the trade. There will without doubt be some inconsistency. There is a wealth of literature about bibliography itself, and this is not the place to discuss it. But it should perhaps be recorded here that the British National Bibliography was started in 1950. It is a weekly catalogue of all books currently published in Great Britain, and the entries are prepared in the British Museum and classified according to the Dewey system. Whitakers are again the publishers, but this time it is a catalogue for the libraries and not for the trade. I do not know whether it is possible to strike a compromise between the rough and the elaborate system, but that would seem to be the need for the purpose of these statistics.

22. Taking the figures of Table 4 as they stand (and they are a useful guide to the general trend), they show that fiction has declined in proportion but still retains the leading place. The highbrows who shake their heads over this high preponderance of fiction in book publishing must remember that the reprints of the classics are included with the worst of the new thrillers. (Of new titles only, 16 per cent. in 1950 were fiction.) Children's books also retain a high place, although booksellers have experienced a falling-off from the high sales which shortage of toys stimulated. At first sight it may seem curious that in 1949 educational books had lost some

ground since before the war. But the figures do not represent total output, and there were, in fact, large editions of old educational books to make good as quickly as possible the deficiency in school books which the war caused.

Output of Individual Publishers

23. Nothing is known about the total output of individual publishers, only about the numbers of titles issued by each. Since 1946 *The Bookseller* has listed twice a year the publishers who have had any production in the preceding six months, and recorded for each the numbers of new titles and reprints, together with the total prices of these publications. The figures in Table 5 have been compiled from these lists. They show the very large number of firms with a small output of new books—perhaps, in part, a reflection of the fact that no professional qualifications are necessary to become a publisher. Sir Stanley Unwin, in a letter to *The Economist* of October 15th, 1949, observed that “about 85 per cent. of the total book trade turnover is represented by the sales of at most fifty firms”. *The Bookseller* calculates for every six months the average price of the titles issued. The variations in price among the bigger publishers is naturally very extensive, but, taken as a group, in the eighteen months beginning July, 1949, they produced new titles at prices somewhat above the average as a whole, but new editions and reprints somewhat below average. There should be no need to add that this does not mean that their new books are more costly, in terms of what is provided.

TABLE 5
*Number of Publishers Producing Books in Six-monthly Periods
Arranged According to Number of Titles Issued*

Number of Titles Issued in 6 Months	Number of Publishers		
	July to Dec.,	Jan. to June,	July to Dec.,
	1949	1950	1950
1-4	745	763	861
5-9	132	116	114
10-14	55	65	57
15-19	27	27	36
20-24	27	18	21
25-29	19	8	13
30-34	10	13	7
35-39	10	4	11
40-44	6	7	8
45-49	6	7	5
50-99	20	14	23
100-199	9	11	9
200 and over	2	1	2
Total	1,068	1,054	1,167

Some Notes on the History of Book Publishing

24. Book publishing, as distinct from book selling, dates mainly from early in the 19th century; formerly the two functions were combined. Booksellers of the Middle Ages did little more than sell manuscripts for authors on commission. The modern system of bookselling dates from soon after the introduction of printing. When William Caxton set up his Westminster printing press with movable type, he is said to have published nearly a hundred books between 1476 and 1491. These works consisted almost entirely of translations. Some records exist about the numbers of booksellers in the 16th and 17th centuries, but there is no real agreement about the size of the trade. The booksellers of those days combined the main branches of publishing and bookselling—they constructed the types, did the printing, kept shops, sold books and stationery as well. According to Edward Arber (ref. 10), there were 837 London publishers (“who were

1951]

by trade printers, engravers, booksellers, bookbinders, etc.") in business at some time between 1553 and 1640. In the year 1640, 147 publishers are recorded. The list is alleged to cover almost all publishers except at the university presses of Cambridge and Oxford, and "comprises the name of every person who registered or transferred a book at Stationers' Hall between 1553 and 1640, and it is hoped that it also includes the names of nearly all those who, during the same period, avowedly published in the metropolis any printed matter without registering the same for publication at Stationers' Hall". Monopoly of printing was vested in the members of the Stationers' Company in 1557, and entry of copies at Stationers' Hall started the following year, but was evidently not always adhered to.

25. The Licensing Act of 1663 was aimed at preventing the publication of "seditious and heretical works". Under its terms the publication of any book was prohibited unless licensed by the Lord Chamberlain, and the number of master-printers in the Kingdom was intended to be reduced to 20. (By this time the various processes of printing and publishing had started to become divorced.) There is no doubt that the terms of this Act were by no means adhered to and there were many prosecutions under it. The publishing trade suffered a severe set-back when the Great Fire of 1666 destroyed printing presses and the main bookselling quarter in St. Paul's Churchyard. The Licensing Act was abolished in 1696, and as a result of this the number of printers in London was greatly increased and presses were set up in the provinces.

26. A number of estimates of book titles published at certain periods have been made by different compilers using various catalogues. I do not think anyone could attach any consistent reckoning to them, but the order of the figures is of some historical interest. According to C. H. Timperley (ref. 23), Clavel's Catalogue records that "the books printed in England between 1666 and 1680 numbered 3,550, of which 947 were divinity, 420 law, and 135 physics—so that two-fifths were professional books, 397 were school-books and 253 were on subjects of geography and navigation, including maps. On the average, therefore, in these 14 years, 253 works were published each year, but deducting reprints, sermons and maps, on the average new books would be much under 100. This will show an increase upon a former period, namely from 1471 to 1600, a period of about 130 years, when the average number of distinct works published each year in this country was 75".

27. The passing of the first Copyright Act in 1709 marked an important point in publishing history, when printing and reprinting of any work was vested in the author for 14 years, and if he lived to the end of that period for another 14 years. The big publishing houses of to-day date from soon after the Act. Longmans, the oldest of those now surviving, was started in 1724. Murray's started forty-four years later in 1768. Again according to C. H. Timperley (ref. 23), the London Catalogue showed that the number of new publications issued between 1800 and 1827, including reprints altered in size and price, but excluding pamphlets, was 19,860. Deducting one-fifth, 15,888 new books are said to have been produced in 27 years, showing an average of 588 new books per year—an increase of 216 per year over the last 11 years of the 18th century. These figures probably refer to London publications only. Much of the information available about publishing in the 18th and 19th centuries relates to the prices paid to the author for his works and to costing in general. M. Plant discusses these aspects, among others, in a general review of the book trade (ref. 20), and gives an extensive list of references. E. Howe has collected together a series of documents relating to working conditions in the London printing trade in the 19th century (ref. 14) which give some interesting sidelights on book and newspaper publishing at that time.

28. Little is known at any time, including the present, about the number of copies sold of any one title. One famous instance on which some information has been recorded was the publication of Macaulay's *History of England*. The first two volumes appeared in 1849, and sold well, but it was the publication of the third and fourth volumes which caused the sensation in the publishing world. According to Curwen (ref. 12), 25,000 copies were printed of these two volumes and were sold in the first day, while the total sale in England and America of the two volumes within four weeks of publication is said to have exceeded 150,000. For the copyright of these third and fourth volumes Macaulay is said to have received £16,000.

29. It was not until the 19th century that booksellers and publishers became separate entities. There are, of course, some old-established firms who still combine bookselling and publishing—for instance, Blackwells, Heffers, and Bowes and Bowes. But in the main the two functions have

been separated and each has its own association—the Publishers' Association and the Booksellers' Association, both being founded in the middle 1890's.

The Net Book Agreement of 1899 sought a remedy for underselling in the fixed price system, allowing discount only to those booksellers who agreed not to sell below the net published price. The agreement has been modified several times, but in principle it remains unchanged. The very cheap, but poorly printed, literature of the latter half of the 19th century which the railway bookstalls had encouraged began to be replaced by better editions with the turn of the century. The first 152 volumes of Everyman's Library were published in 1906 at 1s., and there were a number of cloth-bound editions of standard authors at prices between 2s. and 3s. 6d. These were the forerunners of the attractively produced pocket editions of the 1930's. There are no statistics showing the growth of the retail trade in this century, but it must have been considerable. Membership of the Booksellers' Association (which does not cover the entire retail trade) grew from about 1,000 in 1930 to 1,500 in 1938, and to 2,500 in 1950.

Supplies of Newspapers and Periodicals

Number of Publications

30. There are in the United Kingdom over 4,500 publications which are generally classified as newspapers or periodicals. No definition has been found, however, which draws a completely satisfactory distinction between the two. The Royal Commission on the Press reported: "The term 'newspaper' is usually applied (except so far as concerns the important class of trade newspapers) to publications devoted mainly to recording current events, and 'periodical' to magazines, reviews and journals which, in-so-far as they are concerned with current events at all, are concerned to comment rather than to report; but newspapers merge into advertising sheets, periodicals into books and pamphlets, and both into one another; and statistics have consequently to be treated with caution". Different classifiers may well vary, therefore, in their estimates of even the numbers of newspapers published.

31. The Royal Commission stated that in 1947 there were published in Great Britain 112 general daily newspapers and 18 specialized dailies, 16 Sunday papers, and 1,162 local weekly (including bi-weekly or tri-weekly) papers. Northern Ireland published 5 daily papers and 45 weekly papers in that year. Over 3,000 periodicals (published at intervals varying from a week to six months) are recorded in the trade directories, of which over 1,000 are trade and technical publications. Two annuals which publish detailed lists of newspapers and periodicals are *Willing's Press Guide* (ref. 9) and the *Newspaper Press Directory* (ref. 6), each covering publications issued in the United Kingdom and Eire and giving totals of publications in each class for the area as a whole.

32. In attempting to make any comparison of numbers of publications over any length of time, there are two things to be borne in mind. Firstly, the directory from which the numbers are being counted may become more comprehensive as time goes on. Secondly, local editions of newspapers (mainly weeklies) are sometimes printed for different areas with perhaps one page of special news for that particular area, but otherwise carrying the same material as editions in neighbouring areas. It is not always possible to distinguish between local editions of a single paper and separate papers under the same ownership. However, there is no doubt that the tendency has been for the number of newspapers to decrease. N. Kaldor and R. Silverman (ref. 16) estimated that the number of daily and Sunday papers published in the United Kingdom decreased from 219 in 1920 to 140 in 1944. The Royal Commission, counting only general papers, record a decrease in Great Britain from 169 in 1921 to 128 in 1944 (or 1948). Of weekly newspapers, the Commission reported 1,485 in 1921, 1,432 in 1927, 1,303 in 1937 and 1,162 in 1947. London papers during the years between the wars penetrated a much wider area.

Circulation Figures

33. Circulation figures for certain newspapers and periodicals are collected by the Audit Bureau of Circulation. Quoting from its own words: "Briefly, the objects of the Bureau are to secure, by standard and uniform methods of audit, accurate net sales figures of all media of periodical issue that sell advertising space, and to issue such data to its members at regular intervals—in practice, every six months. Twice a year the Bureau issues to all its publisher members

1951]

sets of standard and uniform audit forms, which indicate the precise method by which, without any variation, the net sales figures are to be ascertained. These audit forms have been drawn up by a committee composed of advertiser, advertising agent and publisher members of the Council".

34. There is some difference in the information required by the Bureau according to the class of publication, although all particulars required are designed to arrive at comparable figures of net sales. The net sales are computed by taking the total of despatches charged to customers per day books (excluding sports and other editions not carrying all advertisements, and also excluding any free and complimentary copies) and adding subscription sales and cash sales. From this total, deductions are made for any returns, any trade and subscription sales at less than full rates, lost or damaged packages, and any other copies not sold at full price to readers for any reason. The completed audit form with the basic information is not required to be returned to the Bureau, so that domestic details remain undisclosed. Instead, a certificate, duly audited, is returned to the Bureau giving a summary. For all types of publication the certificate must show for the period the total net sales, number of publishing days, average net sales and copies sold at less than full rates, the latter being divided between trade and subscription sales. For newspapers, other than provincial weekly ones, separate monthly figures are required, and total average net sales for each of the two fixed audit periods (January 1st to June 30th and July 1st to December 31st). Some provincial weekly newspapers are allowed to select other periods (either six or twelve months), which they are asked to adhere to each year. Generally, however, half-yearly returns ending June and December are received from the provincial weekly newspapers and also the periodicals. Technical, trade and professional journals are asked to return some particulars about their sales overseas. This information is not included in the A.B.C. official handbook, which is circulated privately to its members and shows for each of its publishing members the average net sales; the average number of copies sold, in addition, at less than full subscription rates; and further, in the case of technical, trade and professional journals, the accredited free circulation.

35. The Audit Bureau of Circulations started in 1931, and at October, 1932 it had 101 publishing members. By the middle of 1950 the number had increased to 431. All the national dailies except the *Daily Telegraph* and the *Daily Graphic* and seven out of the ten London Sunday papers now provide A.B.C. figures. All three London evening papers are members. Therefore, although the A.B.C. figures have an increasing coverage and are a good starting-point, comprehensive figures of circulation of any class of publication have to be supplemented by other information. Publishers will often give the particulars and some publish them at intervals. The estimator has then to decide whether these should be adjusted to come into line with the A.B.C. figures, and if so, by how much. For earlier figures than 1931 some help can be obtained from the *Advertisers' A.B.C.*, which ceased in 1931. The London Press Exchange has also collected information over the years.

36. N. Kaldor and R. Silverman (ref. 16) give estimates of the average circulation per issue of newspapers for each year from 1920 to 1944 divided between national and London morning (in which specialized dailies are included); London evening; provincial daily (morning and evening); national and provincial Sunday; suburban and provincial weekly. By interpolation and some reasoned guessing in the earlier years they built up a chain base index of total circulation for each group. The methods used are described, and some idea given of the reliability of the estimates.

37. The Report of the Royal Commission attempts nothing so elaborate. Circulation figures are given only for 1930, 1937, and June, 1947, for the eight national morning papers (the circulation of the *Daily Worker* was available only for 1947 and was therefore not included), the London evening newspapers and the Sunday newspapers. But a comparison of these figures for 1930 and 1937 with those of Kaldor and Silverman does raise certain points. According to the figures published by the Royal Commission, the three London evening newspapers had a circulation in 1930 of 1,767,969, which by 1937 had risen to 1,806,910. The estimates of Kaldor and Silverman show a total of 2,030,000 in 1930 and 1,850,000 in 1937—in other words, a decrease. Why these differences? Kaldor and Silverman state that they add 10 per cent. on to the audited circulation of ordinary editions of the three evening papers to allow for sporting editions (not included in A.B.C. figures unless they carried full advertisements) until these separate editions ceased in

March, 1942. On examining the figures published by the Royal Commission, it appears that sporting editions were included in the 1930 and 1937 figures for *The Star*, but not for the other two London evenings; their inclusion increased the 1937 circulation of *The Star* by about 130,000. The sporting editions of the other two evenings are thought not to have been so large—an estimate around 50,000 in 1937 has been given me for the *Evening Standard*. It may be debatable whether or not these sporting editions should be included, but there seems no reason to include them for one publication and not for the others. However, this cannot entirely explain the discrepancy between the estimates of the Royal Commission and those of Kaldor and Silverman. Another difference arises from the fact that the latter figures included the *Jewish Post and Express* (which ceased publication in 1935) and the *Jewish Evening News* (which ceased publication in 1940). The inclusion of a paper which is not of nation-wide interest at one date and not at another is always bound to add to the difficulties of interpreting the results. The inclusion of the few smaller special London morning papers with the national dailies seems to make little difference to the general trend. Kaldor and Silverman give the circulation of national and London mornings as 8,650,000 in 1930 and 10,210,000 in 1937; the Royal Commission figures are 8,587,567 and 9,903,427. But the figures for Sunday papers again present a difficulty. The Royal Commission show an increase in circulation from 14,600,000 in 1930 to 15,700,000 in 1937; Kaldor and Silverman a decrease from 15,510,000 in 1930 to 15,250,000 in 1937. Possibly more complete information was made available to the Royal Commission than had hitherto been the case; but again, the coverage is slightly different in the two sets of figures.

38. These notes can do no more than show some of the difficulties of interpreting circulation figures. The only attempt at comprehensive figures which I have seen for post-war years since circulations have been "unpegged" are provided by U.N.E.S.C.O. (United Nations Educational, Scientific and Cultural Organization). These figures relate to daily newspapers only which appear six or more times each week, and are reproduced alongside those of other countries, in the *Statistical Yearbook of the United Nations*. In 1949, 122 dailies are recorded for the United Kingdom, having a total circulation of 30 millions. The figures given in Table 6 for certain papers utilize the A.B.C. figures as far as possible (including copies sold at less than full rates), supplemented by information from the individual papers in some cases; the 1930 figures are entirely taken from the Report of the Royal Commission with the exception of that for *The Star*. Because of difficulties of getting comparable figures, the sporting editions of the evening papers have been excluded throughout, but *The Star* was unable to provide the net figure for 1930 and this has been estimated, taking the same proportion for the sporting edition in 1930 as in 1937. The *Sunday Chronicle* has been included with the London Sundays, for although its headquarters are in Manchester there is an edition printed in London. The circulation figures of the *Sunday Referee* are included with those of the *Sunday Chronicle*, with which it was incorporated in 1939. The increase in the circulation of the *Sunday Chronicle* alone between 1930 and 1937 was 48 per cent. By excluding provincial Sunday newspapers, the *Sunday Empire News* does not appear in the table; it is, however, virtually a national paper, and had in 1947 a circulation of around 2 millions.

39. Circulation figures can probably be obtained for the majority of the more important periodicals from the publishers themselves; some provide A.B.C. figures. It may be of interest to record the figures for those "political" or "opinion" weeklies that make them available; they refer to the first half of 1950, including numbers sold at less than full subscription rates, compared with approximate pre-war figures: *The Economist* 46,724 (10,000); *New Statesman and Nation* 87,156 (28,000); *Spectator* 44,349 (24,000); *Time and Tide* about 40,000 (16,000).

Contents of National Daily Papers

40. A valuable report was presented to the Royal Commission on the Press by R. Silverman on the contents of the nine national daily newspapers in 1947, compared with 1937 and 1927, and is included in the final Report. In particular, the investigation analyses from a representative sample of issues of *The Times*, *Daily Mail* and *Daily Mirror* the printed area of each newspaper into advertisements, news, features and other editorial space. It then proceeds to divide the editorial matter into news, features and other editorial matter expressed as a percentage of editorial matter. The subdivision is then taken a stage further, and the different categories of news and

1951]

TABLE 6

Comparative Table of the Circulations of National Morning, London Evening and London Sunday Newspapers

(Circulation figures in thousands)

	1930	Percent- age of Total	1937	Percent- age of Total	1950	Percent- age of Total	1937 as Percent- age of 1930	1950 as Percent- age of 1937
National Morning*								
<i>The Times</i>	186.3	2.2	191.3	1.9	246.8	1.5	102.7	129.0
<i>Daily Telegraph</i> †	295.0†	3.4†	559.3	5.6	979.1	5.9	189.6	175.1
<i>Daily Express</i>	1,693.1	19.7	2,329.9	23.2	4,168.7	25.0	137.6	178.9
<i>Daily Herald</i>	1,118.6	13.0	2,032.8	20.3	2,082.5	12.5	181.7	102.4
<i>Daily Mail</i>	1,845.1	21.5	1,579.6	15.8	2,269.5	13.6	85.6	143.7
<i>News Chronicle</i>	1,451.5	16.9	1,324.1	13.2	1,547.2	9.3	91.2	116.8
<i>Daily Sketch</i>	926.0	10.8	683.5	6.8	785.7	4.7	73.8	114.9
(Graphic)								
<i>Daily Mirror</i>	1,072.0§	12.5	1,328.4	13.3	4,593.0	27.5	123.9	345.7
Total	8,587.6	100.0	10,029.0	100.0	16,672.4	100.0	116.8	166.2
London Evening								
<i>Evening News</i>	714.8	43.9	790.8	47.3	1,742.6	45.3	110.6	220.4
<i>Evening Standard</i>	397.8	24.4	388.0	23.2	866.5	22.5	97.5	223.3
<i>The Star</i>	514.9§	31.6	493.4	29.5	1,237.0	32.2	95.8	250.7
Total	1,627.5	100.0	1,672.3	100.0	3,846.1	100.0	102.8	230.0
London Sunday News- papers								
<i>News of the World</i>	3,410.8	27.2	3,850.1	28.9	8,441.9	29.8	112.9	219.3
<i>The Observer</i>	200.8	1.6	208.1	1.6	429.2	1.5	103.6	206.2
<i>The People</i> •	2,498.6	19.9	3,405.8	25.6	5,136.2	18.1	136.3	150.8
<i>Reynolds News</i>	283.0	2.3	426.0	3.2	705.4	2.5	150.5	165.6
<i>Sunday Chronicle</i> ‡	1,003.0‡	8.0‡	1,071.3‡	8.1‡	1,083.8	3.8	106.8	101.2
<i>Sunday Dispatch</i>	1,197.2	9.5	741.2	5.6	2,487.5	8.8	61.9	335.6
<i>Sunday Express</i>	927.9	7.4	1,338.4	10.1	3,205.3	11.3	144.2	239.5
<i>Sunday Graphic</i>	940.0	7.5	650.9	4.9	1,153.5	4.1	69.2	177.2
<i>Sunday Pictorial</i>	1,946.3	15.5	1,345.2	10.1	5,130.3	18.1	69.1	381.4
<i>Sunday Times</i>	153.0	1.2	270.1	2.0	534.9	1.9	176.5	198.0
Total	12,560.7	100.0	13,307.0	100.0	28,308.0	100.0	105.9	212.7

* Excluding the *Daily Worker*, which had a circulation of 110,000 in 1950.† Including *Morning Post* for 1930 (estimated at 120,000 circulation).‡ Including *Sunday Referee*, 1930 and 1937.

§ Estimates.

of features are shown as percentages of news space and of feature space. It is impossible here to comment adequately on the tables presented. To give an indication of the precision of the estimates Mr. Silverman calculated the margins of errors for a number of categories and these are shown alongside the appropriate tables.

Overseas Trade in Newspapers and Periodicals

41. As with books, the official Trade and Navigation Accounts only provide part of the picture. Those newspapers and periodicals which go in bulk packages, including those by air freight, are entered in the accounts. Thus, the despatches by a wholesaler in this country to one overseas are recorded. But all those sent to individuals by mail—all overseas subscription copies—are lost to record. Overseas trade in newspapers and periodicals is therefore by no means covered

by the Trade Accounts. If the export figures are used, as with books (see paragraphs 12 and 13), newspapers and periodicals, taken together, are only distinguished separately from books from 1948 onwards.

Some Notes on the History of Newspapers

42. The printed newspaper in any quantity dates from the middle of the 18th century. In the previous century news-letters in manuscript were the chief means of spreading news. The first daily newspaper appeared in 1702, a small sheet printed on one side only. The stamp tax of 1712 imposed a halfpenny tax on papers of half a sheet or less, and a penny on those between half and a whole sheet in size. Particulars collected about stamp duties provided figures of newspaper sales. The total number of copies of newspapers sold annually in England increased from about $7\frac{1}{2}$ millions in 1754 to $9\frac{1}{2}$ millions in 1760, and just over 11 millions in 1767. In 1756 the tax was increased by a further $\frac{1}{2}d.$ and rose in stages until by 1815 it had reached $4d.$ In addition, there was a tax on advertisements and a paper duty. Although many newspapers evaded the stamp tax, they were as a whole too dear to reach more than a fraction of the population. In 1836 the stamp duty was reduced to $1d.$ In 1850 there were 15 London dailies with a total daily circulation of about 100,000. The removal of the advertisement tax in 1853, and, more particularly, the repeal of the stamp tax in 1855, brought down the price of newspapers and circulation soared. The last of these taxes—the paper duty—was removed in 1861. The modern type of British periodical grew up in the first half of the 19th century, starting with the *Edinburgh* (1802), the *Quarterly* (1809) and *Blackwood's* (1817). Among the weeklies of to-day, the *Spectator* started in 1828, *The Economist* in 1843.

43. *The Times* (founded in 1785) was priced at $7d.$ in 1815; but in 1861 it was reduced to $3d.$, at which level it remained to the end of the century. Among the national dailies of to-day, the *Daily News* (later the *News Chronicle*) started in 1845; the *Daily Telegraph* in 1855, and almost immediately became the first $1d.$ paper; the *Daily Mail* in 1896, and was the first successful $\frac{1}{2}d.$ daily newspaper, with a circulation of over half a million by 1900; the *Daily Express* started in 1900 also at $\frac{1}{2}d.$, and was the first of the London papers to publish its principal news on the front page. The *Daily Mail* and the *Daily Express* can be said to have started the modern conception of newspaper production as a major industry.

44. At the beginning of this century something of the order of 2,400 newspapers and 2,300 periodicals were being published in the British Isles according to the *Newspaper Press Directory*. Between 1910 and 1920 there were some rapid changes in newspaper prices. *The Times* went from $3d.$ to $2d.$ in 1912; to $1d.$ in 1914, and back again to $3d.$ by 1918. The *Daily Mail* went from $\frac{1}{2}d.$ to $1d.$ in 1917. These changes in price brought sharp changes in circulation. When *The Times* subsequently, in 1922, reduced its price to $1\frac{1}{2}d.$, its circulation is claimed to have increased by some 80,000. The history of the press between the two wars centres round the growth of the chains, which is well covered in the Report of the Royal Commission.

Census of Production, Employment and Paper Statistics

Census of Production

45. No satisfactory information about the book trade can be obtained from the census of production figures which have so far been printed. The 1948 census provides only summary figures for the whole group of printing and publishing other than newspapers and periodicals (group 189 of the Standard Industrial Classification) and full detailed figures must wait for the 1951 census. More detailed, although not comprehensive, information can be obtained from the 1946 census so this, rather than the later one, is discussed further below.

46. The Partial Census of Production in 1946 reviewed the "Printing, Bookbinding, Stereotyping, Engraving and Kindred Trades and the Book, etc., Publishing Trade (Non-printing Firms)". Distinguishing between publishers (non-printing firms) and printers, bookbinders, etc., the general series of figures are available, such as the value of gross and net output and employment. (These figures can be compared with the later ones for 1948 except that the latter refer to Great Britain only.) But the products include an assortment of printed matter—stationery, Christmas cards, account books, and some newspapers and periodicals produced by publishers

1951]

who mainly trade in books. (There is a separate group in the census for newspapers and periodicals under which their main returns are obtained.) What can be obtained separately for books in 1946? The net selling value of the books sold (that is, the amounts charged *less* trade discounts, but including carriage charged to customers with the exception that f.o.b. value is asked for in the case of overseas deliveries) is recorded for those firms who both print and publish, and separately for non-printing publishers (excluding any imports bought and sold in exactly the same condition but including those for which British firms were the publishers). The selling value of printed books recorded for the former firms was £3,460,000 and for the latter £14,518,000. The net advertising revenue is also recorded. But there are two ways in which these figures are incomplete. Firstly, although the census of production normally absolves firms employing not more than 11 persons from returning detailed forms, in 1946 this concession was extended to those firms employing on average from 11 to 49 persons if they wished to avail themselves of it. The concession would probably not make a great difference to the returns from printing firms, but there may well be a number of small publishers who collectively have a sizeable output. And secondly, a certain number of newspaper and periodical firms who make returns in their separate class have some book production. Since newspapers and periodicals were not covered in the 1946 census these have escaped record and their selling value may possibly have amounted to something of the order of a million pounds. For these reasons, fully classified particulars about the book trade are not available for 1946, and comparison with the turnover figures suggest that the census figures fell very short of the total. (The census and turnover figures would not be expected to be identical because of differences in dealing with overseas trade.) In 1935 the deficiency was even greater, for non-printing publishers were not required to make returns—in their case only the amount charged by the printers was recorded. In 1946 the amount charged by printers for work for separate publishers was £6,490,000—not even half the selling value recorded by those non-printing publishers who made returns. The 1935 census set out to measure production, the 1946 census sales.

47. For newspapers and periodicals, the census of production figures are more useful than those for the book trade. But nothing has been published in detail since 1935 (they were not included in the 1946 census, and 1948 figures only relate to the group as a whole and do not even distinguish between newspapers and periodicals). Although the total cost of publication (except printing) was not recorded in 1935 for those newspapers and periodicals owned by publishers who gave all their printing to other forms, returns were obtained from certain important publishers of daily newspapers that did no printing and also from a number of publishers of periodicals; the recorded figures were estimated to be about £2,266,000 short in the value of daily newspapers, and at least £2,000,000 for the other publications. In consequence, the net selling value of daily newspapers produced in 1935 can be put at about £32,500,000, of newspapers other than daily at £12,400,000, and for magazines, reviews, trade journals and similar periodicals altogether at £12,000,000. Without making the adjustment—that is, only taking the value of output as recorded—the volume of production (measured at 1935 prices) of the whole group of newspapers and periodicals was estimated to be 96 per cent. of the 1935 level in 1930 and 81 per cent. of it in 1924. According to the 1948 census, which refers to Great Britain only, the value of the gross output of newspapers and periodicals at current prices was nearly double that of 1935.

Employment and Earnings

48. The Ministry of Labour in its monthly analysis of industrial employment records the numbers of employees for the two groups: (a) printing and publishing of newspapers and periodicals, and (b) other printing and publishing, bookbinding, engraving, etc. The division is according to the Standard Industrial Classification and, as indicated in paragraph 46, the second group includes a variety of printed matter. As with all labour statistics, comparable figures with to-day date back only to mid-1948. Employees in Great Britain at December, 1950, with mid-1948 figures in brackets, numbered in the newspapers and periodicals trade 80,500 (68,500) men and 18,600 (16,900) women, making a total of 99,100 (85,400), and in the second group of other printing and publishing 143,900 (136,700) men and 96,300 (90,100) women, making a total of 240,200 (226,800). Unemployment figures are available on the same basis.

49. Average earnings and hours worked for the same two groups of the paper and printing

trades are given by the Ministry of Labour in their twice-yearly surveys of earnings published in the *Ministry of Labour Gazette*.

Paper Supplies

50. Monthly figures of production, consumption and stocks of newsprint—the grade of paper used in the regular editions of daily and weekly newspapers—are compiled by the Board of Trade and given in the *Monthly Digest of Statistics*; imports can be obtained from the Trade Accounts. Much less is obtainable about other paper used in publishing. Paper production figures in the *Board of Trade Journal* distinguish between newsprint and “other printing and writing” paper. The regular series of consumption statistics relate only to newsprint and “all other paper and board”.

51. There are many different grades of printing paper as opposed to newsprint. Newsprint is usually composed of 75 to 85 per cent. of mechanical pulp and 25 to 15 per cent. of unbleached chemical pulp made by the sulphite process. Book paper often contains a higher proportion of chemical to mechanical pulp, and high quality book paper is made from bleached sulphite pulp. It is difficult to obtain complete information about the uses and consumption of the different grades, but a certain amount has been provided by the Board of Trade in reply to Parliamentary questions. On July 20th, 1950, the President of the Board of Trade said: “It is estimated that daily and weekly newspapers are now using about 88 per cent. of all the newsprint consumed in this country, and that periodicals are using about 11 per cent. The respective proportions were probably 90 per cent. and 8.5 per cent. in 1948, and 92 per cent. and 7 per cent. in 1938–39. Mechanical pulp is used both in the manufacture of newsprint and for mechanical printing paper for periodicals and other uses. It is estimated that newspapers are now using a quantity of paper which represents about 46 per cent. of the total supplies of mechanical pulp, as compared with 55 per cent. in 1948 and 63 per cent. in 1938–39. In 1948 the total consumption of mechanical printing paper by periodicals represented about 16 per cent. of total mechanical pulp supplies, and has probably since increased, but no accurate information is available for 1950 or for the pre-war period”. Previously, in reply to a Parliamentary Question on May 4th, 1950, it had been stated that in the eight months from July 3rd, 1949, to March 4th, 1950, the following approximate quantities of newsprint had been licensed for delivery: 249,000 tons of home-produced and 126,000 tons of imported newsprint for newspapers, and 40,000 tons of home-produced newsprint for periodicals. In the four weeks ending February 12th, 1950, the total newsprint consumed by newspapers was estimated to have been shared in the following proportions: national mornings and evenings 47.6 per cent.; provincial mornings and evenings 24.9 per cent.; local and weekly newspapers 8.5 per cent.; and sporting and Sunday newspapers 19.0 per cent.

52. More comprehensive figures of paper consumption were given in reply to a Parliamentary question on May 6th, 1947, when the Parliamentary Secretary to the Board of Trade announced that the consumption of newsprint in 1946 was 375,000 tons, as compared with 1,200,000 tons in the twelve months ended August 31st, 1939; and of other descriptions of paper (including paper-board) 1,714,000 and 2,605,000 tons for the same periods. He then proceeded to give an approximate analysis of these figures by the main consuming interests; the analysis is reproduced in Table 7.

TABLE 7
Consumption of Paper and Newsprint
(‘000 tons)

	Twelve Months Ending August 31st, 1939	Calendar Year 1946
Newspapers	1,100	327
Periodicals	300	88
Books	63	54
Commercial and general printing	382	255
Wrappings (including food wrapping)	1,405	905
Building trade	92	129
Other industrial uses	306	199
H.M.S.O. and other Government departments	40	71
Export of paper and board	117	61

1951]

53. The Board of Trade has been able to give information about the end uses of paper as a result of the controls brought in during the war years. All restrictions on the use of paper for books and magazines and periodicals were removed on March 1st, 1950, and with the freeing of paper went the means of making estimates such as those in Table 7. (An order reducing newsprint for periodicals came back in February, 1951, but the majority of periodicals use mechanical printing paper which was not affected by the order.) Newsprint for newspapers is still rationed and has gone through many stages of restrictions. The number of pages of the dailies was reduced by half in 1939; in 1940 the penny papers came down to six pages, and in 1941 to four, other papers being reduced in proportion. In September, 1946, the number of pages went up to an average of five for the penny press, and publishers were allowed enough newsprint to produce all the copies they wanted. In July, 1947, to save dollar imports, the penny newspaper was again only allowed four pages and circulations were "pegged" at the level of June, 1947. January, 1949, saw the return of the five-page (that is, an alternation of four and six pages) paper and free sales; on April 25th, 1949, the size of penny newspapers increased to six pages, and at the beginning of 1950 they increased still further to 7 pages. The second half of 1950 saw a cut equivalent to five pages spread over a fortnight. At the time of writing the quota of newsprint is calculated on a 5 per cent. reduction on the 1950 circulation. At the lowest level in 1942 and 1943, newsprint consumption was down to 4,350 tons a week compared with 21,000 tons a week just before the war. In 1950 it averaged about 12,700 tons a week. Estimates made in 1948 showed that the British people still led in buying more newspapers per head of population than any other countries, but in terms of newsprint consumption per head many countries were ahead. Readers interested in statistics of world production, consumption and demand of newsprint are referred to the annual reports of the Newsprint Association of Canada (ref. 7), a study sponsored by UNESCO (ref. 21), and annual statistics of consumption provided by UNESCO and reproduced in the *Statistical Yearbook of the United Nations*.

Newsprint Prices

54. Two prices of newsprint are quoted, "controlled" and "equalized". The Board of Trade purchases the pulp for the home mills and fixes the price of the home-produced newsprint; this is the controlled price. Imports of newsprint are the responsibility of the Newsprint Supply Company (a private company set up in May, 1940, to regulate the distribution of supplies of newsprint) acting under Government licence. The equalized price is arrived at by treating all available supplies as a common pool and averaging out the costs of production and delivery. This price is fixed from time to time by the Company and is the actual price paid by Publishers. Prices vary somewhat according to quantity ordered. The records of the Newsprint Supply Company show that the controlled price of British Standard 22-lb. double crown 480's rose from £12 5s. a ton on September 2nd, 1939, to £46 10s. on January 5th, 1948, followed by a fall to £30 12s. 6d. on January 9th, 1950, and up again to £45 12s. 6d. by January 29th, 1951. Until devaluation, 1949, the controlled price was above the equalized price—imported newsprint from Canada was cheaper than home-produced. After that date the reverse has been true. The trend of differences in the two prices can be seen from the following figures based on quotations for 14-lb. Demy 500's: On August 1st, 1942, the equalized price was £1 per ton cheaper than the controlled; on July 4th, 1949, it was 8s. 9d. a ton cheaper, but on October 3rd, 1949, it was £1 6s. 3d. dearer and on January 29th, 1951, it was 16s. 3d. dearer. Another factor other than devaluation that has favoured the British newsprint price is that home mills are now working to capacity, whereas formerly they were only at about one-fifth capacity.

Finances of Publishing

Book Publishing

55. Since most book publishing firms are private companies, few annual accounts and profit figures are published.

The very varied nature of the publishing trade and the wide range of output between firms make it dangerous to generalize or to attempt to estimate changes in the average cost of book publishing. The observations of two publishers may, however, be mentioned. Sir Stanley Unwin has prepared what he terms a "typical profit and loss account of a moderately successful

novel" in 1939 and 1950 (ref. 24). At both times the novel is a crown octavo book of the same number of words, but takes 288 pages in 1950 compared with 352 pages in 1939 (a reminder that lay-outs have not yet returned to pre-war standards). 1,500 copies of the 1939 book were printed to be sold at 7s. 6d., 3,000 copies of the 1950 book to be sold at 9s. 6d. It purports to show, therefore, not the increased costs of manufacturing at the standards of 1939, but what is actually taking place—the printing of much larger editions. For both years a deficit is shown before making any allowances for publishers' working expenses. Of the manufacturing cost (paper, printing and binding) of the 3,000 copies in 1950, 37 per cent. was for composition, 11 per cent. for paper, 12 per cent. for machining and 30 per cent. for binding; the remaining 10 per cent. covered corrections and jackets. Some interesting figures are also given in the accounting about the allocation of sales on various terms. Since these estimates were made in January, 1950, the main change by March, 1951, has been an increase in the cost of the paper amounting to about 70 per cent. Michael Joseph has given some comparative figures for 1938 and 1948 of the manufacturing cost of producing 5,000 copies of a crown octavo book of 320 pages (ref. 15). In total he puts the figure at £666 in 1948 compared with £249 in 1938—an increase of 166 per cent. Other publishers would doubtless give somewhat different—perhaps very different—estimates, but these accounts are instructive about the factors controlling book prices. A fundamental starting point is the fact that the cost of composition is fixed, however many copies are produced. The attraction of printing large editions is obvious. But the problem of over-printing—the remainder market—was a bitter bone of contention in the publishing world of the 1930's.

56. In addition to the actual cost of manufacturing, there are the costs of advertising, the author's royalty and the publisher's working expenses. Sir Stanley Unwin suggests that about 22 per cent. of total turnover is taken up by a book publisher's working expenses, excluding advertising, but adds, "All the available accounts show great variation in detail, and the total working expenses, excluding advertising, fluctuated between 19 per cent. and 37 per cent.; most of them were over 24 per cent. of the turnover" (ref. 24). This observation shows very plainly the impossibility of attempting to generalize about costs of publishing.

Newspapers and Periodicals

57. Again, the Royal Commission on the Press has made available much interesting information. An appendix to the Report gives particulars of the capital and directors of 35 undertakings owning newspapers and 7 owning periodicals, as filed with the Registrar of Companies on January 1st, 1949. The profit and loss accounts of 53 undertakings were also examined. The total profits (net profits before crediting investment income and before charging taxation) of these undertakings in 1937 are stated to have been £6,857,493 (10·3 per cent. of total capital employed—that is, 10·3 per cent. of issued and loan capital plus reserves, including undistributed profits) and in 1946, £13,732,695 (18·3 per cent. of total capital employed). No further details of profits into subdivisions are given. But during the period 1937–1946 the average net distribution of ordinary profits (after income tax) was approximately 8·816 per cent. per annum. The ratio of profits retained to net distribution was 0·66 to 1, and the ratio of total profits retained over the ten years to the average issued ordinary share capital was 0·57 to 1.

Lord Camrose has devoted a book to the subject of the ownership and control of the Press, which includes his findings on the financing of newspapers (ref. 11).

The Economist includes in its quarterly analysis of industrial profits a group for newspapers and the paper and printing trades; the balance-sheets of 92 such companies were analysed in 1950. *The Financial Times* includes a similar group in its analysis of profits, 77 such companies being covered in 1950.

58. The Report of the Royal Commission gives an analysis of revenue and expenditure in 1937 and 1946 for three groups of newspapers: (a) national mornings and London evenings, (b) 19 provincial morning papers, and (c) 50 provincial evening papers. The shortage of newsprint in 1946 completely altered the economics of newspapers. Advertising revenue as a percentage of total revenue (which is made up of advertising, sales revenue and some very small miscellaneous items) decreased between 1937 and 1946 from 53 per cent. to 25 per cent. in the case of national morning and London evening papers as a whole; from 55 per cent. to 45 per cent. for provincial mornings, and 58 per cent. to 43 per cent. for provincial evenings. The estimates of total expenditure are reproduced in Table 8.

1951]

DEANE—United Kingdom Publishing Statistics

485

TABLE 8

Expenditure on National Morning and London Evening Newspapers*

	1937		1946	
	£ '000	Percentage of Total	£ '000	Percentage of Total
Editorial	2,759	13.9	3,982	23.1
Paper and ink	5,843	29.4	4,495	26.0
Production (including wages)	4,146	20.9	3,671	21.3
Circulation (including transport)	3,301	16.8	2,369	13.7
Other	3,759	19.0	2,757	15.9
Total	19,808	100.0	17,274	100.0

* Excluding the *Daily Worker*.

59. Kaldor and Silverman (ref. 16) carried out an extensive piece of research into the relative contributions of sales and advertisements to newspaper revenue. Their estimates cover the years 1934–1938 and also 1943. The gross sales revenue was calculated from circulation figures; the net sales revenue was devised by deducting an estimate for wholesale and retail margins and other costs of distribution. Advertising revenue was calculated from figures supplied in most cases by the newspapers themselves. For 1937 there is fair agreement between their estimates and those of the Royal Commission. Advertising rates charged by individual newspapers and periodicals are given in *The Advertiser's Annual* (ref. 1). While rates are to some extent based on the cost per inch per thousand readers, the relation is by no means a direct one. At the time of writing, many publications are increasing their rates and advertising costing is in a state of flux. Any straightforward attempt to estimate advertising revenue of a publication by costing a sample of issues in the light of the published charges would probably fail owing to the different rates accorded to special positions.

Two articles in *The Economist* at the beginning of 1948 reviewed the economics of newspapers (ref. 13).

Kaldor and Silverman also include rough estimates for the sales and advertising revenue of periodicals in 1935, dividing the types of periodical into general interest, special interest, technical and trade; the results are subject to a good degree of uncertainty.

*Consumer Expenditure on Reading Matter**Personal Expenditure*

60. The annual National Income White Paper provides figures of total personal expenditure on reading matter divided between books, newspapers and magazines. (Magazines include time-tables, programmes and miscellaneous papers.) The expenditure is for purchases only—library subscriptions are not included. The 1950 and 1951 White Papers were less useful than their predecessors as a means of comparing the current price and volume of consumption with those of pre-war. The price index is given for the separate groups only for 1949 and 1950 compared with 1948 and for reading matter as a whole for 1948 compared with 1938. However, with the aid of previous White Papers it is possible to compile the figures given in Table 9.

TABLE 9

Personal Expenditure on Reading Matter

	At Current Prices (£ million)			At 1938 Prices (£ million)		Index Numbers (1938 = 100)	
						Price	Volume
	1938	1949	1950	1949	1950	1950	1950
Books	10	33	35	22	23	152	230
Newspapers	36	65	66	59	59	110	165
Magazines	18	39	48	32	38	127	210

Retail Prices

61. In the revaluation of consumer expenditure at 1938 prices, the Government statisticians try to take account of changes in quality, but confess that there are many difficulties. This is particularly true for newspapers. Most of the apparent increase in the consumption of newspapers is said to be due to the fact that no account has been taken of changes in size. The price index, also, makes no allowance for this factor. So, although the price of newspapers is shown to be only 10 per cent. higher in 1950 than in 1938, the purchaser gets a much smaller paper for that rather higher price. Of the London daily newspapers, only two increased their price during the last war—the *Daily Telegraph* went from 1d. to 1½d., and *The Times* from 2d. to 3d. A number of provincial papers raised their price.

Book prices, according to the consumer price index, increased between 1938 and 1950 by about 52 per cent. First thoughts may doubt that it was as much as that. The 7s. 6d. pre-war novel was only 8s. 6d. or 9s. 6d. However, cheaper books have had to be increased proportionally to a greater extent. For instance, the price of Penguins was raised from 6d. to 9d. in April, 1942; to a shilling in January, 1946, and to 1s. 6d. in January, 1948. Books in the Everyman Library are now 4s. 6d. compared with 3s. before the war. For those interested in the price at which rare books change hands, the transactions at auction sales are recorded annually (ref. 2). *The Bookseller*, from its six-monthly survey of new titles issued by individual publishers (see paragraph 23), works out the average price of new titles. These averages have to be unweighted—that is, they take no account of the numbers of copies of each title produced. On this basis, for the four six-monthly periods starting January 1st, 1949, and ending December 31st, 1950, the average price of new books (as opposed to new editions) was 11s. 6d., 11s. 9d., 12s. 9d. and 12s. 5d., and the average price of new editions and reprints was 9s. 7d., 10s. 5d., 10s. 7d. and 11s. 7d. This analysis excludes Government publications.

*Library Statistics and Readership Surveys**Public Libraries*

62. For the general public libraries which are not under central government control there is no official collection of library statistics. Statistics are collected, however, by the Library Association—a private professional body. This association circulates once a year to each public library authority in the United Kingdom a questionnaire asking for particulars of (a) population of library area; (b) number of issues from lending libraries (distinguishing, if possible, between fiction, non-fiction and juvenile books); (c) expenditure divided between books (excluding periodicals), binding, salaries and other items; and (d) numbers of staff. These questionnaires have been circulated each year since the end of the war; previously surveys were only taken at certain times. The statistics cover the 12 months ending March 31st, except for Scottish libraries, which run for the 12 months ending May 15th. There is no legal obligation for libraries to complete the forms, but the response has been good. In 1949–50, for instance, libraries returning the questionnaires (although not completely in a few instances) served a population of 49,130,458 out of the estimated total of 49,430,000. The yearly summary figures issued by the Library Association include an estimate of the missing figures. The growth of the service of the public libraries is shown in Table 10. Expenditure on books includes those bought for the reference sections of the libraries.

TABLE 10

Public Library Statistics

Year	Books Issued from Lending Libraries ('000)	Expenditure on Books (£ '000)	Total Expenditure of Libraries (£ '000)
1877/78	8,604	n.a.	83
1895/96	26,225		286
1910/11	54,256		805
1923/24	85,668		1,398
1934/35	207,982	507	2,441
1938/39	247,335	n.a.	3,178
1948/49	312,000	1,870	7,606
1949/50	306,100	2,170	8,653

1951]

63. Per head of population in 1949/50, 6.2 books were issued from the lending libraries, expenditure on books was $10\frac{1}{2}d.$, and total library expenditure $3s. 6d.$ The results of these inquiries are published in *The Library Association Record* (ref. 4), where an analysis is made of the issues and expenditure according to the size of population served by the library authorities.

64. The number of library authorities has increased from 28 in 1860 to 586 to-day. There has been some decrease in the last ten years, owing to some smaller authorities being amalgamated under larger ones. The actual service points have, however, continued to increase, and were 23,000 in 1949, compared with 18,000 in 1939 and 480 in 1896. In 1949 there were altogether about 12 million registered borrowers, but this figure gives no indication of the activity of borrowing, since there must be many rate-payers who have tickets but use them very infrequently. However, assuming that these were all active borrowers, the expenditure on books per borrower in 1949/50 was about $3s. 6d.$

65. There are no national figures of the types of books borrowed or in stock at the public libraries. From annual reports issued by various library authorities a certain amount of information can be gathered. The detail in which these reports are presented varies enormously from one authority to another; some are bare of figures, while others give in some detail particulars of stock and books borrowed. From these reports it has been estimated that the total stocks of books in all the public libraries are about $42\frac{1}{2}$ million to-day, compared with $32\frac{1}{2}$ million in 1939, $10\frac{1}{2}$ million in 1911, and $1\frac{1}{2}$ million in 1878. What evidence is available suggests that, as a whole, something of the order of one-third of the books borrowed are non-fiction. But, for instance, the City of Westminster reported that of books on loan to adult borrowers on March 31st, 1950, as many as 46 per cent. were works of non-fiction.

66. It would obviously be desirable for statistics about public libraries to be made available in a more uniform way. Yet the problems of adequate classification might well make the task too formidable. The extent of the division into subjects obviously depends on the size of the library. For instance, under the broad classification adhered to in many libraries, books on entertainments such as card-games are classified under the broad heading of Fine Arts. That is but one example of the anomalies that may result from any analysis of books by subject.

Government Libraries

67. Some Government libraries are open for reference to the public and therefore perhaps a general mention should be made. The expenditure on books for the various departments' libraries are all financed out of the vote for the Stationery Office and a total expenditure figure is given for books and maps. The large national libraries, such as those of the British Museum (with a bookstock of about 5 million volumes) and the Science Museum (about 345,000 volumes) have expenditure on books entered under their separate votes in Class IV of the Civil Estimates.

Commercial Libraries

68. The first subscription booklender was Charles Edward Mudie, who started a lending library in 1842, charging an annual subscription of 1 guinea. There are to-day the two distinct types of commercial library, those still referred to as the $2d.$ libraries, although, in fact, most of them lend books at $3d.$ or $6d.$ rates, and the subscription libraries. Little is known about the volume of trade of the first type, but it is believed to reach the largest number of book-lenders after the public libraries—on what evidence I do not know, and the relative importance of the two types of library must vary considerably according to locality. Of the subscription libraries, Boots and W. H. Smith have kindly supplied the following figures: From the branches of Boots' libraries the approximate number of books issued in a year was 12 millions in 1922, 27 millions in 1929, 38 millions in 1939, and 50 millions in 1950. At the present time about 25 million exchanges are made through the branches of W. H. Smith's libraries in a year.

Readership Surveys

69. The number of copies sold of a publication is no measure of the number of people who read it. Readership surveys try to get an idea, amongst other things, of the extent to which publications are shared. As far as books are concerned, however, no extensive surveys have been made. Mass-Observation carried out a national sample survey of book reading in 1947,

but it consisted of only 1,000 interviews. One person in every three of this sample said they did not read books, and within this group of non-readers there were a disproportionate number of married people, women and the less well-off or less well-educated. Also, older women read books less than the young. In the previous year, Mass-Observation had carried out an investigation into reading habits in Tottenham, on behalf of the borough council. 968 people were interviewed, of whom over half said they read books; 4 out of 5 in the 16–20 age-group, 3 out of 5 in the 20–24 group, and 2 out of 5 over 40 years of age. An attempt was made to analyse the readers who belong to public libraries according to social class.

The British Institute of Public Opinion has also examined book-reading habits, surveys being taken on samples of 2,000 people. Early in 1951, 51 per cent. of people were found to be reading books. In November, 1949, the figure was 55 per cent., and in January of the same year 51 per cent. The survey in November, 1949, analysed the type of book being read and how it was obtained. 16 per cent. of the sample were reading a book they owned, 21 per cent. one from the public library, 5 per cent. one from the *2d.* library, 6 per cent. one from a subscription library, and 7 per cent. were reading a book borrowed from a friend. These figures are contrary to the belief that the *2d.* library reaches a much larger public than the subscription library. The sample was too small, however, to draw any general conclusion, but the survey indicates the type of answers being sought.

70. Some more ambitious surveys have been made of the reading of newspapers and periodicals. The largest surveys have been provided by the Hulton Readership Surveys (ref. 5). These are designed to give advertisers a guide to the readership of the more important newspapers and periodicals and are carried out by Research Services Ltd. under the directorship of Dr. Mark Abrams. The initial survey was made in 1947. Several improvements in method were made in 1948, when a sample of 12,600 was covered; 13,000 interviews were carried out in 1949 and in 1950. The sampling is done on a quota system using a stratified sample of the civilian population of Great Britain aged 16 years and over. Informants were asked which daily newspaper they had read on the previous day, which Sunday paper they had read the previous Sunday, and which weekly paper they had read during the last 7 days. Results have been analysed by age, sex, regionally and economic status. Looking at the results for the three years 1948 to 1950, the percentages of the whole sample reading any national morning paper varied between 77·3 and 80·2; reading any national Sunday paper between 89·4 and 90·6; and any evening paper between 64·8 and 69·1 per cent. In all these cases, although the variation is fairly small, there was an increase between 1948 and 1950. 1950 saw a general contraction in the number of readers per copy bought. In the setting-out of the results, some indication of their reliability is afforded by the fact that a distinction is made between the figures of which the standard deviation is less than 10 per cent. of the answer, and those where it is 10 per cent. or more. According to the results of the 1950 survey, the ratio of readership to circulation was in the region of 12 to 1 for periodicals such as *Punch* and *Lilliput* and of 2·5 to 1 for the majority of daily papers.

71. The Social Survey carried out an inquiry into newspaper reading in 1943 covering the civilian adult population (taken as aged 14 and over). The report issued by Louis Moss and Kathleen Box (ref. 18) analyses the 5,639 answers. While reading habits may well be different in wartime and peacetime, and there were restrictions on the sales of newspapers in 1943, the general results are in fair agreement with the more recent Hulton Surveys. Sunday newspapers were found to reach the largest public, morning papers were seen by about three-quarters of the population, and evening papers and local weeklies by about a half.

Another press survey—that of Mass-Observation prepared for the Advertising Service Guild during parts of 1947 and 1948 (ref. 17)—is of general rather than statistical interest. The aim was to discover why people read newspapers, what they look for in a newspaper and the extent of the influence of the Press. The inquiry was an ambitious one, but was only carried out on a small scale. No dogmatic conclusions can be drawn from this report, and Mass-Observation wisely makes no attempt to do so.

72. It might be wrong to avoid drawing attention to some of the drawbacks to readership surveys, however obvious they may seem. Firstly, there is the overriding question of what is implied by readership of a publication—is it “reader-interest” which may be taken as no more than turning the pages, or should there be an attempt to establish a minimum definition of reading? As many of the surveys of newspapers and periodical reading have been designed for advertisers,

1951]

the stress has been on the first conception, and the questions framed have been in the sense of "seeing" a paper. Secondly the accuracy of the answers to some of the questions must depend upon the memory of the respondent. And thirdly, habit-questioning is always open to the doubt of whether the respondent is influenced by what he feels the answer *ought* to be to the detriment of what it actually is. There is an obvious challenge to prestige in inquiries of this type. Adding the general problems of sampling, readership surveys need cautious handling.

Bibliography

Those in the first part are publications which have been issued regularly—in the case of annuals the date of the latest available at time of writing is shown.

April, 1951

Part I

1. *Advertiser's Annual, The* (1950), Business Publications Ltd.
2. *Book Prices Current* (1947), H. F. & G. Witherby.
3. *Bookseller, The* (weekly), J. Whitaker & Sons.
4. *Library Association Record, The* (monthly), The Library Association.
5. *Hulton Readership Survey* (1950), (J. Hobson, H. Henry and M. A. Abrams), Hulton Press.
6. *Newspaper Press Directory, The* (1951), Benn Brothers.
7. *Newsprint Data* (1950), Newsprint Association of Canada.
8. *Whitaker's Cumulative Book List* (quarterly), J. Whitaker & Sons.
9. *Willing's Press Guide* (1951), Willing's Press Service.

Part II

10. ARBER, EDWARD (1890), *A List of London Publishers, 1553–1640 A.D.*
11. CAMROSE, VISCOUNT (1947), *British Newspapers and Their Controllers*. Cassell.
12. CURWEN, H. (1873), *A History of Booksellers*. Chatto & Windus.
13. *Economist, The* (February 21st, 1948, and February 28th, 1948).
14. HOWE, E. (1947), *The London Compositor, 1785–1900*. Oxford University Press.
15. JOSEPH, M. (1949), *The Adventure of Publishing*. Allan Wingate.
16. KALDOR, N. & SILVERMAN, R. (1948), *A Statistical Analysis of Advertising Expenditure and the Revenue of the Press*. (National Institute of Economic and Social Research.) Cambridge University Press.
17. Mass-Observation (1949), *The Press and its Readers*. Art & Technics Ltd.
18. MOSS, L. & BOX, K. (June-July, 1943), *Newspapers and the Public*. The Social Survey, Central Office of Information.
19. PEP (Political and Economic Planning) (1938), *Report on the British Press*.
20. PLANT, M. (1939), *The English Book Trade*. George Allen & Unwin.
21. *Problem of Newsprint and other Printing Paper, The* (1949). Prepared by The Economist Intelligence Unit, for UNESCO.
22. *Royal Commission on the Press, 1947–49: Report* (June, 1949; Cmd. 7700). H.M. Stationery Office.
23. TIMPERLEY, C. H. (1839), *A Dictionary of Printers and Printing*. London: H. Johnson.
24. UNWIN, Sir STANLEY (6th edition, 1950), *The Truth About Publishing*. George Allen & Unwin.

URBAN POPULATION DENSITIES

By COLIN CLARK

THIS branch of Geography does not yet seem to have received adequate quantitative study. The figures of density of population of cities sometimes published in reference books are practically meaningless. Arbitrary administrative decisions as to how much rural or semi-rural land is to be included within the city boundaries may completely alter the results. Fruitful study of urban population densities can only be made by drawing a map of the city and plotting, either by stippling or shading, the densities of population by the smallest component areas (Census Tracts or administrative sub-divisions) for which data are available. The task is laborious and the results lacking in precision; but its application to a number of cities in different parts of the world and at different dates for which the evidence could be obtained has yielded some very interesting preliminary results.

The student of urban development will be greatly dependent upon Professor Griffith Taylor's *Urban Geography* (14) and the great learning therein contained. But this book is essentially designed to discuss qualitative criteria for ascertaining the various stages in the development of a town, with special emphasis upon the small town. Quantitative analysis of densities, with particular reference to great metropolitan areas, is hardly dealt with in it.

This subject has attracted two brilliant statistical geographers—curiously enough, a long time ago, and there appears to have been little work since they wrote. The problem appealed to the versatile and painstaking genius of Mark Jefferson. In the *Bulletin of the Geographical Society* (predecessor of the *Geographical Review*) of 1909 (7), he published a series of density maps of the principal U.S. cities, based on the Census of 1900, and also of a number of European cities. By doing his work at this time he probably preserved much of the information from irreparable oblivion. For, while we still have, in the U.S. Census Reports, records of the population of each Ward and Assembly District in the big cities, it is very doubtful whether any information has been preserved which will enable us now to draw the boundaries of such districts.

Perhaps even more credit is due to the French scientist Meuriot, who published in 1898 *Des Agglomérations Urbaines dans l'Europe Contemporaine* (10), a book which remains to this day an outstanding study of nineteenth century urbanization in all its aspects. This book included a large number of density maps of contemporary European cities, and also traced their past development.

The preparation and detailed study of dozens of density maps is an overwhelming task unless we can begin with some hypothesis which will enable us to organize and simplify the data. We can begin with two generalizations the validity of which is now universally recognized:

1. In every large city, excluding the central business zone, which has few resident inhabitants, we have districts of dense population in the interior, with density falling off progressively as we proceed to the outer suburbs.
2. In most (but not all) cities, as time goes on, density tends to fall in the most populous inner suburbs, and to rise in the outer suburbs, and the whole city tends to "spread itself out."

The evidence assembled below appears to be sufficient to show that, in practically every case, the falling off of density, as we proceed to the outer suburbs, follows a simple mathematical equation of *exponential decline*.

Let x be distance in miles from the centre of the city.

Let y be the density of resident population in thousands per square mile.

Then (except in the central business zone)—

$$y = Ae^{-bx}.$$

That the falling off density is an exponential function, as in the above equation, appears to be true for all times and all places studied, from 1801 to the present day, and from Los Angeles to

1951]

Budapest. This maintenance of the exponential relationship is, however, compatible with very different rates of decline of density, as measured by the co-efficient b . A high value of b means that density will decline sharply with increasing distance from the centre, i.e., a compact city; a low value means that density declines more slowly, and the city is more spread out. It is clear that b is largely dependent upon the costs of intra-urban transport, or, more precisely, the cost of travelling in relation to the average citizen's income. Only where this cost is low can citizens afford to "spread out." The co-efficient A , on the other hand, measures the density or, shall we say, degree of over-crowding, which the citizens are prepared to tolerate at the centre of the city. At the centre of the city in the formula, x is equal to zero and y , therefore, becomes equal to A . It is a hypothetical rather than an actual figure, because in fact the centre of the city is occupied by the business zone with few or no resident inhabitants. Nevertheless it remains a useful figure; it shows the point to which densities are tending, if we measure the densities of the inner residential suburbs and continue extrapolating them inwards to reach the centre of the city.*

To use this formula it was found convenient to calculate total population, and hence average density, in a series of concentric rings about the centre of the city, generally drawn at each mile radius. Where these circles cut the boundaries of the Census Tracts or other administrative divisions by which the original data were classified, arbitrary apportionments of population had to be made. This was done in proportion to the area to the tract lying in each ring, after known open spaces (e.g., parks and mountains) had been excluded. Where the tracts are very small, as for U.S.A., 1940, Liverpool, Manchester and Dublin, this does not introduce any serious error. For the remainder of the British data, and for the Australian data, the tracts were larger, while for the rest of the data not only were the tracts large but the exact density was not given, only the "density class" being shown.

If we were to perform the whole investigation afresh, it would obviously be better to plot, for each tract, the recorded average density against its mean distance from the centre of the city, as this would eliminate the errors due to the apportionment process, and give a better picture of the scatter about the regression line.

The determination of the co-efficients A and b is now comparatively simple. A diagram is prepared in which the horizontal co-ordinate is a distance in miles from the centre of the city to the mid-point of the ring under examination, and the vertical co-ordinate is the *natural logarithm*

* The two co-efficients A and b must also be mathematically related to the total population of the city. If density of population, in thousands per square mile, at distance x from the centre of the city, is given by the formula—

$$y = Ae^{-bx}$$

then the total population within a radius r is given by—

$$\begin{aligned} & \int_0^r Ae^{-bx} (2\pi x) dx \\ &= 2A\pi \int_0^r e^{-bx} x dx \\ &= 2A\pi \left[-\frac{e^{-bx}}{b^2} (1 + bx) \right]_0^r \\ &= \frac{2A\pi}{b^2} \{1 - e^{-br} (1 + br)\} \end{aligned}$$

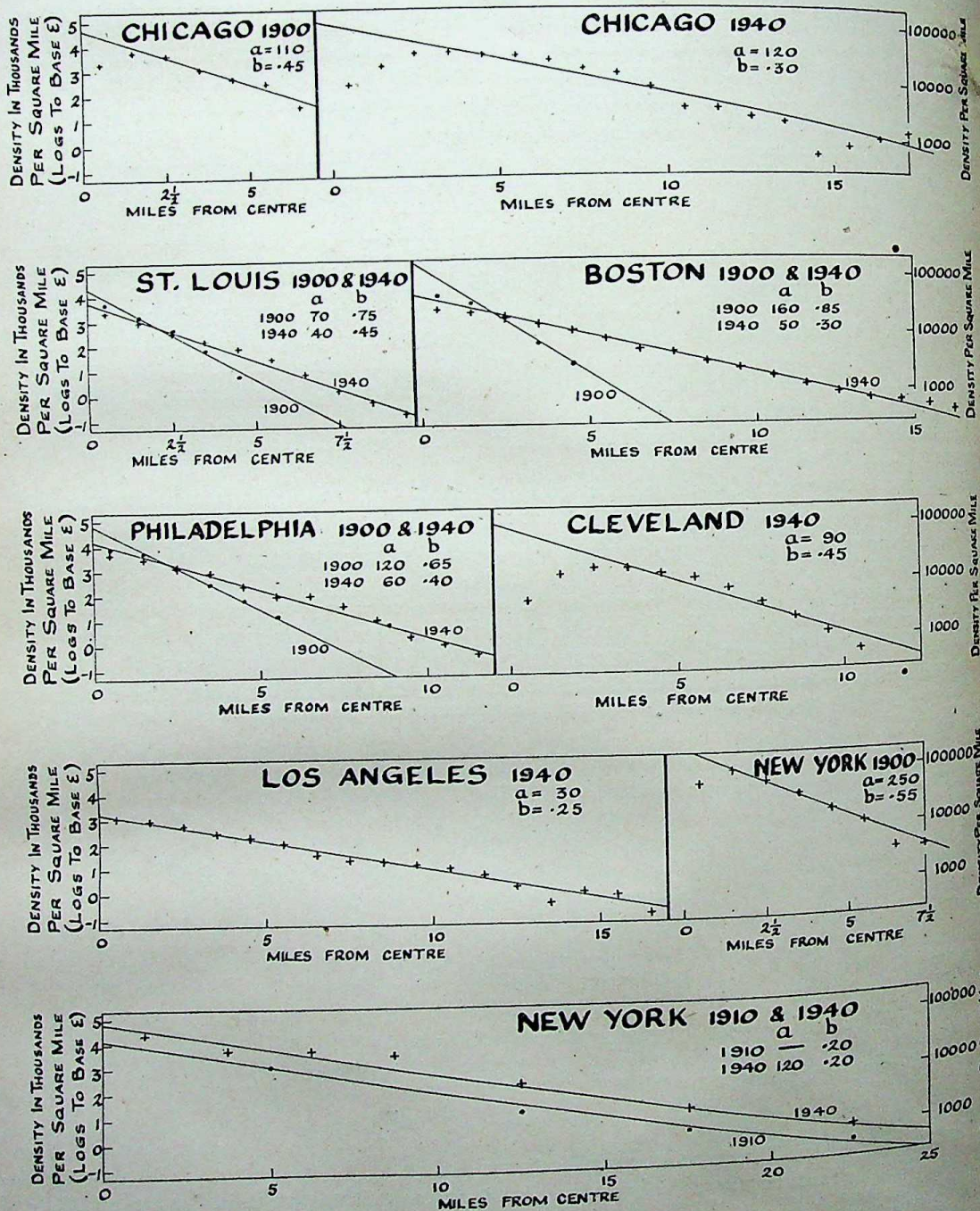
when $r = \alpha$ (i.e., to obtain the total population of the city, in thousands) this becomes—

$$\frac{2A\pi}{b^2}$$

This result, however, is still subject to two qualifications :

- (i) We have made no allowance for the space in the central business zone, which is not available for residence.
- (ii) We have assumed that the city can spread out uniformly and that all the land is available for residential building, i.e., no sea, estuaries, mountains, national parks, or the like.

Trying out the above formula allowing for these two considerations, would be a useful matter for further analysis. At this stage it can only be remarked that the values of A and b for various cities, ascertained below, do give at any rate the right order of magnitude for total populations.



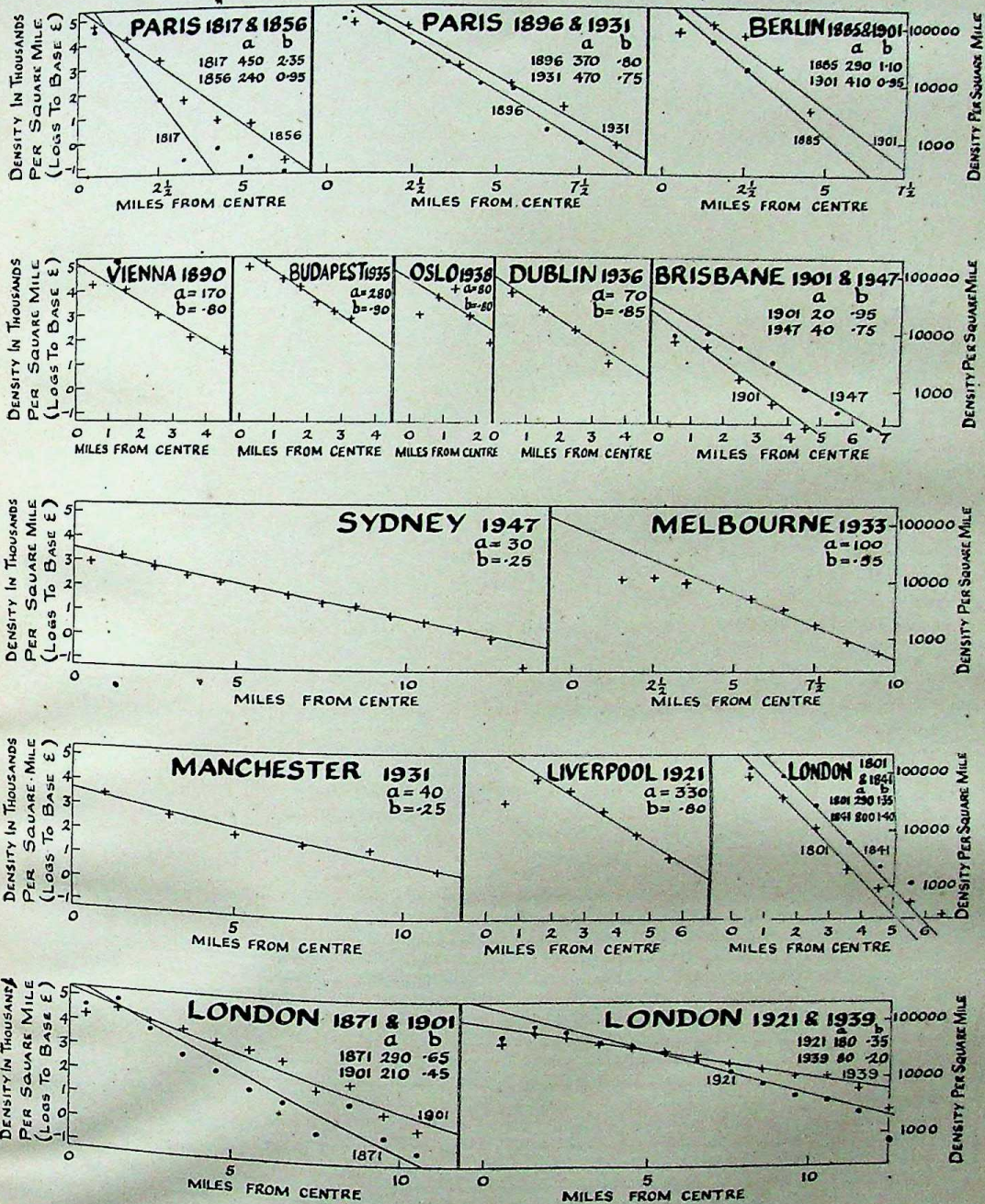


TABLE 1.

Parameters in the Expression $y = Ae^{-bx}$ Relating Density of Resident Population in Thousands per Square Mile to Distance in Miles from the Centre of the City

Region, City and Date	A	b	Region, City and Date	A	b
Australia—			Continental Europe (continued)—		
Brisbane			Oslo		
1901	20	.95	1938	80	.80
1947	40	.75	Paris		
Melbourne			1817	450	2.35
1933	100	.55	1856	240	.95
Sydney			1896	370	.80
1947	30	.25	1931	470	.75
British Isles—			Vienna		
Dublin			1890	170	.80
1936	70	.85	United States of America—		
Liverpool			Boston		
1921	330	.80	1900	160	.85
London			1940	50	.30
1801	290	1.35	Chicago		
1841	800	1.40	1900	110	.45
1871	290	.65	1940	120	.30
1901	210	.45	Cleveland		
1921	180	.35	1940	90	.45
1939	80	.20	Los Angeles		
Manchester			1940	30	.25
1931	40	.25	New York		
Ceylon—Colombo			1900	250	.55
1946	60	.40	1910	?	.20
Continental Europe—			1940	120	.20
Berlin			Philadelphia		
1885	290	1.10	1900	120	.65
1901	410	.95	1940	60	.40
Budapest			St. Louis		
1935	280	.90	1900	70	.75
			1940	40	.45

Sources of Information

U.S. Cities 1940—from Census Populations by tracts in the principal cities and by townships and other minor civil divisions in the remaining part of the metropolitan area.

Maps of census tracts and of civil divisions in the outer part of metropolitan areas, and their populations, given in the Census Reports on Populations, vol. i, Number of Inhabitants (15).

All U.S. figures for 1900 from Jefferson (7). New York figures for 1910 from Regional Planning Association; these do not analyse distribution within the first ten miles from the centre of the city.

Meuriot's data (10) used for Paris, Berlin and Vienna.

Figures for Paris for 1931 from Demangeon, *Paris—la Ville et sa Banlieue* (5).

Data for Budapest and Dublin from Density maps published in *Geographical Review* in 1943 (2) and 1946 (16) respectively, and for Liverpool from density map published in the *Journal of the Royal Statistical Society*, 1930 (8).

Figures for Manchester and all the surrounding metropolitan area from density data given in *City of Manchester Plan*, prepared by the City Council, 1945 (12).

Figures and map for Oslo from the Municipal *Statistisk Årbok* (13).

For London the Registrar-General of England and Wales publishes estimates by parliamentary divisions, used for 1939; and Census data for the same divisions for 1921. In the English Census of 1871 a special effort was made to preserve and render comparable figures of London's population by civil parishes back to 1801. The Parish boundaries were taken from maps published in Charles Booth's *Life and Labour in London* (3).

For Melbourne figures were taken from Dr. Fooks's book *X-ray the City!* (6).

For Sydney and Brisbane estimates were made direct from Census returns (1).

1951]

of the density, measured in thousands per square mile. In this way we can plot the equation as a straight line:

$$y = Ae^{-bx}$$

$$\therefore \log_e y = \log_e A - bx.$$

The calculated values of A and b are shown in Table 1 and diagrams are attached for all the cities for which information is available. It will be seen that in each case the data lie approximately along a straight line, except for the central business zone, where the resident population is always smaller than might have been expected. The value of A is determined from the point at which this line cuts the vertical axis, and the value of b from its slope.

These results do enable us to give a simplified classification of cities and of their trend of growth. If a metropolitan area is to have a high total population, it must either put up with a considerable degree of overcrowding in the inner suburbs, or it must spread itself out; this is the verbal expression of the mathematical equation given in the previous footnote. Spreading out is only possible where transport costs are low in relation to the citizens' income. A city with fairly high transport costs will have a fairly high value of b , and as its total population grows, the value of A (degree of overcrowding at the centre) must necessarily rise.

We naturally expect to find b at its maximum in those few records we have of the early nineteenth century, where it stood at 1.4 in London and perhaps as high as 2.35 in Paris. These were cities entirely dependent upon foot and horse transport, and even the latter was only for the few. There were horse buses in both cities, but they were not extensively used. The higher figure for Paris is probably determined by the longer hours of the Parisian worker, and his inability to walk the distance which some Londoners were willing to walk.

At the other end of the scale we get minimum values of b approaching 0.2 in present-day London, New York and Los Angeles, with Manchester, Sydney and Chicago not far behind. Their transport depends upon cheap underground railways in New York and London, surface electric railways in Chicago and Sydney, and largely upon private automobiles in Los Angeles.

But it is certainly surprising to see the similarity of the diagrams for Los Angeles and Manchester, two cities which one would believe, on first impressions, to be poles apart.* The coefficient A is higher for Manchester (somewhat greater crowding at the centre) but their co-efficients b are very similar. Los Angeles claims to have achieved its dispersal through growing up in the automobile age and relying on that form of transport. Manchester and the adjacent towns grew up in the nineteenth and first years of the present century, and for transport relied upon steam trains and tramcars.† But they have managed to achieve almost the same degree of dispersal as Los Angeles. One reason is that factories and other places of employment are well distributed around Manchester. This is in violent contrast to Liverpool, where places of employment are largely centred along a narrow water-front, and where a large population has accumulated so impoverished and distressed by casual employment that it cannot afford the time or money for tram journeys.

Where we complete on one diagram figures for one city at two different dates, we can at once see the two possibilities for development, if the population is increasing. Either transport costs are reduced, enabling the city to spread out; or they cannot be reduced, in which case density has to increase at all points. In the former case we get a diagram of two intersecting lines, in the latter case two lines more or less parallel. An interesting example of the latter is the development in London between 1801 and 1841. There was no significant improvement in transport in this period, and density rose at all points. But when we go forward to 1871, with a widespread service of steam trains and horse buses, we notice a complete change of slope; b has fallen from 1.41 to 0.66.

In Paris we can see this change as early as 1856. By 1896 the value of b for Paris had fallen to 0.79. But since then there has been little further fall. The Métro has been electrified, but the fares are high in relation to Parisian wages; more important is the belief of the Parisian worker

* After visiting each of these cities twice during recent years, one does however get the impression that in its production of smoke and industrial litter Los Angeles is now doing its best to imitate the physical appearance of Manchester, so far as its climate will allow.

† Until about twenty years ago, when some of the tramcars were replaced by buses, it was possible to go right across the County of Lancashire, from the sea to the Yorkshire border, in a succession of tram journeys. The present writer has performed this feat.

that his two-hour lunch interval should be devoted to its proper purpose, and not wasted in travelling; for him to have to live at such a distance from his work that he has to eat his lunch away from home is a real hardship.

In 1900 Chicago had the lowest value of b for all American cities. It is interesting to read Jefferson's comments on the high degree of dispersal, by the standards of that time, which Chicago had already achieved, and the good health (again by the standards of that time) which its inhabitants enjoyed. London in 1901 had a similar value of b ; but its value of A was nearly twice Chicago's, and severe overcrowding prevailed in the inner suburbs. Between 1900 and 1940 we can trace heavy declines in the value of b in each of the American cities examined. The particularly violent decline in Boston is perhaps attributable to the electric railway.

For New York it would be of great interest to obtain more detailed figures for 1910, if they are anywhere to be found. We have no data for the inner suburbs, but those for the outer suburbs show that already by this date a distribution with a very low value of b generally obtained. The Subway and electric services on the main line railways were in use by this date, and fares were low in relation to New York wages. But it is particularly interesting to note that between 1910 and 1940 little further reduction of transport costs has been possible, and as a result the city has had to grow by increasing density at nearly all points.

We may conclude with some isolated evidence of urban population densities at other times and places, and compare them with the figures we have here. The world's first urban development is believed to have been the city of Ur, and Sir Leonard Woolley (17) estimates that this city in its mature phase about 2,000 B.C.,* covered 4 square miles of compact building area, with a population of 500,000, or 125,000 to the square mile. Something of this sort seems to have been the maximum density which our remote ancestors would tolerate. Professor Demangeon, in his book, gives detailed measurement of the Parisian city boundaries and population in 1329, and the density works out at 142,000 per square mile. Professor Judges (9) has prepared a population map of all London parishes in 1695. The innermost residential area (within one-quarter of a mile of the London Stone) had a population density of 140,000 per square mile, but outside this one-quarter-mile radius it fell to approximately 120,000.

There seems to be statistical evidence for Lewis Mumford's attack (11) on the nineteenth century industrial city, which, he claimed, compelled people to live at densities unheard of in previous cities. In Paris by 1861, for instance, the population of the four innermost *arrondissements* had risen to 180,000 per square mile—which is also the population of the most densely populated areas in present-day Budapest. But a world record, which it is to be hoped will never again be challenged, was established in Jefferson's studies, which showed that some parts of the Lower East Side in New York in 1900 were carrying population at the rate of 350,000 per square mile.

Bibliography

- (1) Australia. Census Returns—Sydney and Brisbane.
- (2) BEYNON, E. D. (1943), *Geogr. Rev.*, 33, 264.
- (3) BOOTH, CHARLES, et al. (1902), *Life and Labour of the People in London*. 3rd series, 1-7. London: Macmillan.
- (4) Census of England and Wales, 1921 (1922). County of London, Tables, Part I. — 1871 (1872), Population Tables, vol. ii.
- (5) DEMANGEON, A. (1949), *Paris—la ville et sa Banlieue*. Paris: Bourrelie.
- (6) FOOKS, E. (1946), *X-ray the City!* Melbourne: Ruskin Press.
- (7) JEFFERSON, M. (1909), *Bull. Amer. Geogr. Soc.*, 41, 537.
- (8) JONES, D. C., and CLARK, C. G. (1930), "Housing in Liverpool: a survey by sample, of present conditions," *J. R. Statist. Soc.*, 93, 489.
- (9) JONES, P. E., and JUDGES, A. V. (1935), "London Population in the late seventeenth century," *Econ. Hist. Rev.*, 6, 45.
- (10) MEURIOT, P. (1898), *Des Agglomérations Urbaines dans l'Europe Contemporaine*. Paris: Belin Frères.
- (11) MUMFORD, L. (1938), *The Culture of Cities*. London: Secker & Warburg.
- (12) NICHOLAS, R. (1945), *City of Manchester Plan*. Manchester City Council.
- (13) *Statistik Årbok for Oslo By*. Oslo: Bureau Municipal de Statistique.
- (14) TAYLOR, T. G. (1949), *Urban Geography*. London: Methuen.
- (15) U.S.A. *Sixteenth Decennial Census, 1940*. (1942). Population, vol. i.
- (16) WILSON, L. S. (1946), *Geogr. Rev.*, 36, 597.
- (17) WOOLLEY, C. L. (1934), *Ur Excavations*, 2, Part I. London: British Museum.

* It is believed to have been at about this date that Abraham exchanged his home in Ur for the austere life of a desert nomad.

1951]

RECENT ADVANCES IN MATHEMATICAL STATISTICS

BIBLIOGRAPHY, 1943-47

*Communication from the National Physical Laboratory**Introduction*

This bibliography is a continuation of that compiled by Miss Rigg for 1940-42 (*J. R. Statist. Soc.*, 1946, 109, pp. 395-450), and covers papers, published during the years 1943-47, which deal with the development of some aspect of statistical theory, or the application of statistical method to practical problems.

The method of classification of the theory group has been altered a good deal; this could well be more detailed than before in view of the large number of papers to be listed. It was found convenient to use a condensation of the scheme adopted for the card index of statistical literature prepared by the Statistics Section of the Mathematics Division at the National Physical Laboratory. Cross-classification was unfortunately impracticable for reasons of space; this caused some difficulty, since many papers could appropriately come under more than one heading; in addition quite a large number of foreign papers had to be classified on the basis of a title or a very brief review; however, the amount of misclassification would, it was felt, be sufficiently small to be outweighed by the advantages of the method.

A list of the headings, under which the papers are arranged in alphabetical order by authors, is given below. For the Theory Group these fall into six main sections. Section 1 is devoted to papers which deal primarily with mathematical and computational methods which are useful in statistical work. Papers which discuss the solution of combinatorial problems connected with the design of experiments should strictly come in this section, but have been placed for convenience in Section 4.4. Section 2 is concerned with problems in probability, without the emphasis on the associated idea of a frequency or distribution function. 2.1 deals with the foundations of the subject—questions such as building up the theory from a set of axioms and the meaning of randomness. 2.2 deals with probability problems described in geometric language, 2.3 with a miscellaneous collection of probability problems which include matching problems and rank correlation.

Much of present-day statistics is essentially a study of distribution functions. This subject is covered in Section 3. 3.1 deals with systems of frequency curves, such as Pearson's or Gram Charlier's (but not with fitting them to actual data, which, since this is a problem of statistical inference, occurs in section 4.1 or in section 5.13). 3.2 deals with properties of a single distribution function such as the characteristic function, moments, cumulants and correlation. 3.3 deals with properties of groups of distribution functions; the majority of papers in this section are concerned with limit theorems. 3.4 deals with the evaluation of particular distribution functions and with the transformation of variates, which often plays an important part in such problems. 3.5 is devoted to tables, chiefly of probability levels.

Sections 4 and 5 are concerned with the use of statistical inference. Section 4 deals with the general theory, and 5 with particular sampling problems. The subdivision of section 4 is straightforward, but that of section 5 needs further explanation. The underlying idea, which forms the basis of an elaborate subdivision in the scheme adopted for the National Physical Laboratory card index, is that all sampling problems can be expressed in terms of questions about a particular mathematical model which describes the population from which the samples are taken. The most obvious characteristic of such a model is the number of random variates involved—this leads to the main subdivision into 5.1, univariate, 5.2, bivariate, and 5.3, multivariate. Another important feature is whether a single sample or several samples are under consideration; this is the basis of another subdivision in the card index scheme, but there are not sufficient papers here for it to be worth while making the distinction. Section 5.1 is further subdivided according to the kind of question that is being asked about the model. We may be interested in—

1. Measures of location.
2. Measures of spread.

3. Measures of spread and location jointly.
4. Measures of shape.
5. All characteristics—i.e., fitting frequency curves.
6. Tests for randomness (not strictly comparable with 1 to 5, but included here for convenience).

In the card index scheme each of the above categories is the basis of a separate subdivision—here 2 and 3, 4 and 5 have been amalgamated. There is an additional subdivision 5.111 for the very important class of problems involving linear hypotheses, which includes analysis of variance and regression. Sections 5.2 and 5.3 could of course be similarly divided, but the number of papers was not thought sufficiently great to warrant this.

A number of papers here may seem at first sight to come under an "applications" heading. Thus in 5.11 we find fraction defective sampling schemes, in which we are asking questions about the *mean* of a binomial or hypergeometric distribution, and probit analysis, in which we are asking questions about the parameters involved in the law connecting the *mean* of a binomial distribution with the value of an independent variable. These two subjects are respectively associated with industrial and biological applications. In 5.3 we find factor analysis, which was introduced in psychological work. However, such techniques are not necessarily confined to the particular fields in which they originated and, since the papers in question are primarily concerned with the development of their techniques, it seemed appropriate that they should come in this theoretical bibliography.

In Section 6, which deals with stochastic processes, a satisfactory scheme of detailed classification could not be found. A subdivision into three main headings, corresponding to foundations, properties of processes and estimation and tests of hypotheses suggested itself; but, as might be expected from the way in which the subject has been developing recently, the great majority of papers come under the second heading. However, even this subdivision may be of some little use. Here again there are a number of papers which seem to be concerned specifically with applications to particular subjects such as the counting of elementary particles, the distribution of telephone calls, the theory of turbulence, noise in electrical circuits, and so on, but in most cases it was considered that there was sufficient emphasis on some new aspect of the theory to justify their inclusion in this group.

The "Applications" Group of the bibliography is intended to cover the applications of mathematical statistics to the subjects set out below. In compiling the lists, the general principle was to include only those papers in which new statistical techniques were suggested (some of these papers will be found also in the "Theory" section of the bibliography), or those in which standard techniques were applied to new or important fields of application. These criteria, which are by no means well defined, introduce an inevitably subjective element into the selection. The uncertainty as to what should be included was increased by the fact that the bibliographers were able to see at first hand only a small proportion of the papers.

In general all papers on applications appearing in statistical journals have been included; but for the remainder only the leading journals in each subject have been searched. Since, in almost every section, these include abstracting journals such as *Biological Abstracts* or *Science Abstracts* the field covered is fairly wide. Although the lists are intended to cover the years 1943-47, a few earlier papers omitted from the 1946 collection have been included here.

Although the sections are subdivided they are not mutually exclusive. The reader who is interested in one particular sub-section is advised to glance through the other sub-sections, and also at the other sections of the bibliography.

A. BIOGRAPHICAL AND GENERAL

B. THEORY

1. Mathematical Methods

- 1.1. Transforms and special functions.
- 1.2. Solution of equations (algebraic, differential, integral).
- 1.3. Matrix theory and linear equations.
- 1.4. Interpolation and quadrature.
- 1.5. Computation of statistics.

2. Elementary Probability

- 2.1. Foundations.
- 2.2. Geometric probability.
- 2.3. Calculus of probability and arrangement problems.

3. Distribution Functions

- 3.1. Systems of frequency curves.
- 3.2. Transformation of a distribution function: moments, cumulants, characteristic function, etc.
- 3.3. Properties of distribution functions: including limit theorems and convergence, arithmetic of distribution functions and regression theory.
- 3.4. Evaluation of particular distribution functions: transformation of variates.
- 3.5. Tables.

4. Sampling Theory

- 4.1. Choice of distribution curve.
- 4.2. Theory of significance tests.
- 4.3. Theory of estimation.
- 4.4. Design of experiments and sampling techniques.

5. Sampling Problems and Tests of Particular Hypotheses

- 5.1. Univariate.
 - 5.11. Measures of location.
 - 5.111. Linear hypotheses including analysis of variance, regression, etc.
 - 5.12. Measures of spread, spread and location.
 - 5.13. Measures of shape, and comparison of frequency curves.
 - 5.14. Tests for randomness.
 - (5.15. Miscellaneous.)
- 5.2. Bivariate.
- 5.3. Multivariate.

6. Stochastic Processes

- 6.1. Foundations.
- 6.2. Properties of processes.
- 6.3. Estimation problems and tests of hypotheses.

*C. APPLICATIONS**1. Biology*

- 1.1. Human populations.
- 1.2. Animal and microbial populations.
- 1.3. Allometry and anthropology.
- 1.4. Biological assay and potency estimation.
- 1.5. Medical statistics and epidemiology.
- 1.6. Miscellaneous.

*2. Agriculture**3. Forestry**4. Genetics**5. Psychology**6. Industry**7. Computation**8. Miscellaneous Applications*

Acknowledgments

Section B, Theory, the sub-section on Industrial Applications and the collation of the remainder were carried out as part of the research programme of the National Physical Laboratory, and this paper is published by permission of the Director of the Laboratory.

The name of the bibliographer responsible for the collection and preparation of the material for each section is given under the section title.

A. BIOGRAPHICAL AND GENERAL

P. ARMITAGE

1. ANDERSON, J. A. (1945), "The role of statistics in technical papers", *Trans. Amer. Ass. Cereal Chem.*, **3**, 69-73.
2. ANON. (1945), "Facilities for statistical study offered at various centres in India", *Math. Stud.*, **13**, 117-23.
3. ANON. (1947), "Report on the teaching of statistics in universities and university colleges", *J. R. Statist. Soc.*, **110**, 51-7.
4. ANON. (1947), "First report of the Examinations Committee, as amended and adopted by the Council", *J. R. Statist. Soc.*, **110**, 58-69.
5. ANON. (1947), "The teaching of statistics", *Engineering*, **164**, 38.
6. ANON. (1947), "Overzicht van de voornaamste publicaties op het gebied van de wiskundige statistiek, waarvan besprekingen voorkomen in enige statistische en economische tijdschriften, 1940-46", *Stat. econ. Onderz.*, *Utrecht*, **2**, 23-6.
7. BAINBRIDGE, J. R. (1947), "The teaching of statistics", *Engineering*, **164**, 448.
8. BLOMMERS, P. (1945), "Statistical theory. Some recent developments", *R. Educ. Res.*, **15**, 423-40.
9. BROOKES, B. C. (1947), "The incorporation of statistics into a school course", *Math. Gaz.*, **31**, 211-8.
10. BUROS, O. K. (1945), "Statistical methodology index. A quarterly guide to current literature", *J. Amer. Statist. Ass.*, **40**, 417-23, 539-52.—(1946) Ditto, **41**, 144-54; 270-4; 415-20; 625-35.—(1947) Ditto, **42**, 203-8; 353-5; 491-6; 668-81.
11. COCHRAN, W. G. (1945), "Training at the professional level for statistical work in agriculture and biology", *J. Amer. Statist. Ass.*, **40**, 160-6.
12. COCHRAN, W. G. (1946), "Graduate training in statistics", *Amer. Math. Mon.*, **53**, 193-9.
13. CORNELL, F. G. (1945), "Training to supply the demand", *J. Amer. Statist. Ass.*, **40**, 167-71.
14. DEMING, W. E. (1945), "On training in sampling", *J. Amer. Statist. Ass.*, **40**, 307-16.
15. HURWITZ, A. & MANN, F. C. (1946), "The membership of the American Statistical Association—an analysis", *J. Amer. Statist. Ass.*, **41**, 155-70.
16. NEISWANGER, W. A. & ALLEN, H. K. (1947), "A well-rounded curriculum in statistics", *Amer. Statist.*, **1**, 16-9.
17. PENGLOU, C. (1946), "Le champ d'application de la méthode statistique", *J. Soc. Statist. Paris*, **87**, 146-62.
18. PIETRA, G. (1944), "La statistique méthodologique italienne de 1939 à 1942", *Rev. Inst. Int. Statist.*, **12**, 36-45.
19. VAN REST, E. D. (1946-7), "Applied statistics in England", *Statist. (Lieden)*, **1**, 5-11.
20. RIGG, F. A. (1946), "Recent advances in mathematical statistics. Bibliography of mathematical statistics (1940-42)", *J. R. Statist. Soc.*, **109**, 395-450.
21. RODRIGUES, M. DE S. (1945), "On the training of statisticians", *J. Amer. Statist. Ass.*, **40**, 172-4.
22. SHEWHART, W. A. (1946), "The advancing statistical front", *J. Amer. Statist. Ass.*, **41**, 1-15.
23. SMITH, O. S. (1946), "We recommend the teaching of statistics in high school", *Math. Teacher*, **39**, 182-3.
24. STEVENS, N. E. (1947), "The anecdote as an antidote to statistical analysis", *Chron. Stat.*, **11**, 188-90.
25. THIONET, P. (1945), "L'école moderne de statisticiens italiens", *J. Soc. Statist. Paris*, **86**, 245-55.
26. WALKER, H. M. (1945), "The role of the American Statistical Association", *J. Amer. Statist. Ass.*, **40**, 1-10.
27. WILKS, S. S. (1947), "Personnel and training problems in statistics", *Amer. Math. Mon.*, **54**, 525-8.
28. WINSOR, C. P. (1944), "Biometry", *M. Physics*, 89-110.
29. WRIGHT, A. (1943), "An excursus on the terminology of statistical experimentation", *Lancet*, **245**, 657.

B. THEORY

A. M. WALKER

1. MATHEMATICAL METHODS

1.1. Transforms and Special Functions

30. BANCROFT, T. A. (1945), "Note on an identity in the incomplete Beta function", *Ann. Math. Statist.*, **16**, 98-9.
31. CAMERON, R. H. & MARTIN, W. T. (1947), "The orthogonal development of non-linear functionals in series of Fourier-Hermite functionals", *Ann. Math.*, **48**, 385-92.

32. CAMERON, R. H. & MARTIN, W. T. (1947), "Fourier-Wiener transforms of functionals belonging to L_2 over the space C^n ", *Duke Math. J.*, **14**, 99-107.
33. NICOLINI, T. (1945), "Un tipo di curva a curvatura distribuita come la densità della probabilità nella legge normale", *R. C. Accad. Sci. Fis. Mat. Napoli*, **13**, 109-15.
34. TRUESDELL, C. (1947), "A note on the Poisson-Charlier functions", *Ann. Math. Statist.*, **18**, 450-4.

1.2. Solutions of Equations (Algebraic, Differential, Integral)

35. KATZ, L. (1946), "On the class of functions defined by the difference equation $(x+1)f(x+1) = (a+bx)f(x)$ ", *Bull. Amer. Math. Soc.*, **52**, 827.
36. LEVENBERG, K. (1944), "A method for the solution of certain non-linear problems in least squares", *Quart. J. Pure Appl. Math.*, **2**, 164-8.
37. NATTA, G. (1945), "Leggi di ripartizione delle singole specie molecolari nei prodotti di una catena di reazioni successive", *Ist. Lombardo Sci. Lett. Cl. Sci. Mat. Nat. Rend.* (3), **9** (78), 307-20.
38. OTTAVIANI, G. (1947), "Su una equazione integrale della statistica matematica", *Mem. Accad. Lincei. Rend. Cl. Sci. Fis. Mat. Nat.*, **3**, 59-63.
39. PAILLOUX, H. (1946), "Sur un problème de répartition", *Ann. Univ. Grenoble Sect. Sci. Math. Phys.*, **21**, 123-5.
40. RUTMAN, M. A. (1946), "Concerning a paper by T. A. Sarymsakov", *C. R. Acad. Sci. U.R.S.S. Doklady*, **52**, 567-8.
41. TARJAN, R. (1944), "Untersuchungen zum Erneuerungsproblem nichtkonstanter Gesamtheiten", *Mitt. Ver. Schweiz. Versich.-Math.*, **44**, 95-105.

1.3. Matrix Theory and Linear Equations

42. ALBERT, A. A. (1944), "The minimum rank of a correlation matrix", *Proc. Nat. Acad. Sci. Wash.*, **30**, 144-6.
43. ALBERT, A. A. (1944), "The matrices of factor analysis", *Proc. Nat. Acad. Sci. Wash.*, **30**, 90-5.
44. BARANKIN, E. W. (1945), "Bounds for the characteristic roots of a matrix", *Bull. Amer. Math. Soc.*, **51**, 767-70.
45. BERRY, C. E. (1945), "A criterion of convergence for the classical iterative method of solving linear simultaneous equations", *Ann. Math. Statist.*, **16**, 398-400.
46. BOSCHMAN, P. (1946), "The consolidated Doolittle technique", *Bull. Amer. Math. Soc.*, **52**, 826.
47. VAN BOVEN, A. (1947), "A modified Aitken pivotal condensation method for partial regression and multiple correlation", *Psychometrika*, **12**, 127-33.
48. BOWKER, A. H. (1947), "On the norm of a matrix", *Ann. Math. Statist.*, **18**, 285-8.
49. BRUNER, N. (1947), "Note on the Doolittle solution", *Econometrika*, **15**, 43-4.
50. DUNCAN, W. J. (1944), "Some devices for the solution of large sets of simultaneous linear equations", *Phil. Mag.*, **35**, 660-70.
51. DWYER, P. S. (1944), "A matrix presentation of least squares and correlation theory with matrix justification of improved methods of solution", *Ann. Math. Statist.*, **15**, 82-9.
52. DWYER, P. S. (1945), "The square root method and its use in correlation and regression", *J. Amer. Statist. Ass.*, **40**, 493-503.
53. FARNELL, A. B. (1944), "Limits for the characteristic roots of a matrix", *Bull. Amer. Math. Soc.*, **50**, 789-94.
54. GUTTMAN, L. (1944), "General theory and methods for matrix factoring", *Psychometrika*, **9**, 1-16.
55. GUTTMAN, L. (1946), "Enlargement methods for computing the inverse matrix", *Ann. Math. Statist.*, **17**, 336-43.
56. HOTELLING, H. (1943), "Further points on matrix calculation and simultaneous equations", *Ann. Math. Statist.*, **14**, 440-1.
57. IDELSON, N. (1943), "On the computation of the weights of the unknowns in the method of least squares", *Astr. J. Soviet Union*, **20**, 11-3.
58. LEAVENS, D. H. (1947), "Accuracy in the Doolittle solution", *Econometrika*, **15**, 45-50.
59. LINDLEY, D. V. (1946), "On the solution of some equations in least squares", *Biometrika*, **33**, 326-7.
60. LONSETH, A. T. (1944), "On relative errors in systems of linear equations", *Ann. Math. Statist.*, **15**, 323-5.
61. ORTS, J. M. (1944), "On certain iterated probabilities", *Rev. Mat. Hisp.-Amer.*, **4**, 153-8.
62. SAIBEL, E. (1944), "A rapid method of inversion of certain types of matrices", *J. Franklin Inst.*, **237**, 197-201.
63. SATTERTHWAIT, F. E. (1946), "Retention of decimal places in matrix calculations", *Bull. Amer. Math. Soc.*, **52**, 828.
64. TUCKER, L. R. (1944), "The determination of successive principle components without computation of tables of residual correlation coefficients", *Psychometrika*, **9**, 149-53.
65. ULLMAN, J. (1944), "The probability of convergence of an iterative process of inverting a matrix", *Ann. Math. Statist.*, **15**, 205-13.
66. WAUGH, F. V. (1945), "A note concerning Hotelling's method of inverting a partitioned matrix", *Ann. Math. Statist.*, **16**, 216-7.
67. WAUGH, F. V. & DWYER, P. S. (1945), "Compact computation of the inverse of a matrix", *Ann. Math. Statist.*, **16**, 259-71.

1.4. Interpolation and Quadrature

68. CHERN, S. S. (1945), "On Grassman and differential rings and their relations to the theory of multiple integrals", *Sankhyā*, 7, 2-8.
69. GREVILLE, T. N. E. (1947), "Remark on the note 'A generalization of Waring's formula'", *Ann. Math. Statist.*, 18, 605-6.
70. GREVILLE, T. N. E. (1944), "A generalization of Waring's formula", *Ann. Math. Statist.*, 15, 218-9.
71. LADERMAN, J. & ABRAMONOWITZ, M. (1946), "Application of machines to differencing of tables", *J. Amer. Statist. Ass.*, 41, 233-7.
72. NIESSEN, A. M. (1945), "On the summation of certain progressions useful in time series analysis", *J. Amer. Statist. Ass.*, 40, 98-100.
73. PIERCE, J. A. (1944), "On the summation of progressions useful in time series analysis", *J. Amer. Statist. Ass.*, 39, 387-9.
74. RICHARDSON, J. T. (1946), "A table of Lagrangian coefficients for logarithmic interpolation of standard statistical tables to obtain other probability levels", *J. R. Statist. Soc. Suppl.*, 8, 212-5.
75. SREEDHARAN, P., K.C. (1943), "Trend analyser", *Proc. Ind. Acad. Sci., Sect. A*, 17, 187-94.

1.5. Computation of Statistics

76. BARTLETT, N. R. (1946), "A punched card technique for computing means, standard deviations, and the product-moment correlation coefficient and for listing scattergrams", *Science*, 104, 374-5.
77. FOSTER, G. A. R. (1946), "Some instruments for the analysis of time-series and their application to textile research: Symposium on 'Auto-correlation in time-series'", *J. R. Statist. Soc. Suppl.*, 8, 85-97.
78. FREAR, D. E. H. (1945), "Punched cards in correlation studies", *Chem. and Eng. News*, 23, 2077.
79. KEMPTHORNE, O. (1946), "The analysis of a series of experiments by the use of punched cards", *J. R. Statist. Soc. Suppl.*, 8, 118-27.
80. MORGAN, T. D. & CRAWFORD, F. W. (1944), "Time-saving computing instruments designed for spectroscopic analysis", *Oil Gas J.*, 100-5.
81. PLATT, J. R. (1943), "A mechanical determination of correlation coefficients and standard deviations", *J. Amer. Statist. Ass.*, 38, 311-8.
82. SZATROWSKI, Z. (1946), "Calculating the geometric mean from a large amount of data", *J. Amer. Statist. Ass.*, 41, 218-20.
83. WAUGH, F. V. (1946), "The computation of partial correlation coefficients", *J. Amer. Statist. Ass.*, 41, 543-6.

2. ELEMENTARY PROBABILITY

2.1. Foundations

84. BARTLETT, M. S. (1945), "Negative probability", *Proc. Camb. Phil. Soc.*, 41, 71-3.
85. BERGMANN, G. (1945), "Frequencies, probabilities and positivism", *Philos. and Phen. Res.*, 6, 26-44.
86. CARNAP, R. (1945), "The two concepts of probability", *Philos. and Phen. Res.*, 5, 513-32.
87. HALMOS, P. R. (1944), "The foundations of probability", *Amer. Math. Mon.*, 51, 493-510.
88. HELMER, O. & OPPENHEIM, P. (1945), "A syntactical definition of probability and of degree of confirmation", *J. Symbolic Logic*, 10, 25-60.
89. KAUFMANN, F. (1945), "Scientific procedure and probability", *Philos. and Phen. Res.*, 6, 47-66.
90. MARGENAU, H. (1945), "On the frequency theory of probability", *Philos. and Phen. Res.*, 6, 11-25.
91. MISES, R. VON (1945), "Comments on Donald Williams' paper", *Philos. and Phen. Res.*, 6, 45-6.
92. MISES, R. VON (1945), "On the probabilities in a set of games and the foundation of probability theory", *Rev. Cienc. Lima*, 47, 435-56.
93. NAGEL, E. (1945), "Probability and non-demonstrative inference", *Philos. and Phen. Res.*, 5, 485-507.
94. REICHENBACH, H. (1945), "Reply to Donald C. Williams' criticism of the frequency theory of probability", *Philos. and Phen. Res.*, 5, 508-12.
95. SALES, F. (1947), "Some considerations on the foundations of the theory of errors", *Rev. Mat. Hisp. Amer.*, 7, 165-72.
96. SINGH, J. (1946), "Theories of probability", *Sankhyā*, 7, 257-62.
97. WILLIAMS, D. (1945), "On the derivation of probabilities from frequencies", *Philos. and Phen. Res.*, 5, 449-84.
98. WILLIAMS, D. (1945), "The challenging situation in the philosophy of probability", *Philos. and Phen. Res.*, 6, 67-86.
99. WRIGHT, G. H. VON (1945), "Über Wahrscheinlichkeit. Eine logische und philosophische Untersuchung", *Acta Soc. Sci. Fenn. Nova Ser. A*, 3, 11, 66.

2.2. Geometric Probability

100. ADLER, H. A. & MILLER, K. W. (1946), "A new approach to probability problems in electrical engineering", *Trans. Amer. Inst. Elect. Engrs.*, 64, 630-2.
101. BOSE, R. C. (1946), "The patch number problem", *Science and Culture*, 12, 199-200.
102. DOMB, C. (1947), "The problem of random intervals on a line", *Proc. Camb. Phil. Soc.*, 43, 329-41.
103. EGGLETON, P. & KERMACK, W. O. (1944), "A problem in the random distribution of particles", *Proc. Roy. Soc. Edin. Sect. A*, 62, 103-15.

1951]

104. FINNEY, D. J. (1947), "The significance of associations in a square point lattice", *J. R. Statist. Soc. Suppl.*, **9**, 99-103.
105. GHOSH, B. (1943), "On the distribution of random distances in a rectangle", *Science and Culture*, **8**, 388.
106. GHOSH, B. (1943), "On random distances between two rectangles", *Science and Culture*, **8**, 464.
107. GOUDSMIT, S. (1945), "Random distribution of lines in a plane", *Rev. Mod. Phys.*, **17**, 321-2.
108. GREENWOOD, MAJOR (1946), "The statistical study of infectious diseases", *J. R. Statist. Soc.*, **109**, 85-103; discussion 103-10.
109. HADWIGER, H. (1943), "Über gleichwahrscheinliche Aufteilungen", *Z. Angew. Math. Mech.*, **22**, 226-32.
110. KRISHNA IYER, P. V. (1947), "Random association of points on a lattice", *Nature*, **160**, 714.
111. LOVERA, G. (1947), "Questioni statistiche sulla distribuzione temporale degli eventi casuali", *Ricerca Sci.*, **17**, 2042-4.
112. MORAN, P. A. P. (1947), "Random associations on a lattice", *Proc. Camb. Phil. Soc.*, **43**, 321-8.
113. MORAN, P. A. P. (1947), "The random division of an interval", *J. R. Statist. Soc. Suppl.*, **9**, 92-8.
114. MULLENMEISTER, H. (1945), "Mean lengths of line segments", *Amer. Math. Mon.*, **52**, 250-2.
115. SILBERSTEIN, L. (1945), "The probable number of aggregates in random distributions of points", *Phil. Mag.*, **36**, 319-36.
116. TIETZE, H. (1947), "Würfelspiel und Integralgeometrie", *S. B. Math. Nat. Abt. Bayer Akad. Wiss.*, 1945/1946, 131-58.
117. WALTERS, A. G. (1947), "The distribution of projected areas of fragments", *Proc. Camb. Phil. Soc.*, **43**, 342-7.

2.3. Calculus of Probability and Arrangement Problems

118. ANDERSON, T. W. (1943), "On card matching", *Ann. Math. Statist.*, **14**, 426-35.
119. BATICLE, E. (1946), "Le problème des stocks", *C. R. Acad. Sci. Paris*, **222**, 355-7.
120. BOREL, E. (1947), "Sur les probabilités dénombrables et le pari de Pascal", *C. R. Acad. Sci. Paris*, **224**, 77-8.
121. CHUNG, K. L. (1943), "On fundamental systems of probabilities of a finite number of events", *Ann. Math. Statist.*, **14**, 123-33.
122. CHUNG, K. L. (1943), "Further results on probabilities of a finite number of events", *Ann. Math. Statist.*, **14**, 234-7.
123. CHUNG, K. L. (1943), "Generalization of Poincaré's formula in the theory of probability", *Ann. Math. Statist.*, **14**, 63-5.
124. CHUNG, K. L. & HSU, C. (1945), "A combinatorial formula and its application to the theory of probability of arbitrary events", *Ann. Math. Statist.*, **16**, 91-5.
125. DANIELS, H. E. (1944), "The relation between measures of correlation in the universe of sample permutations", *Biometrika*, **33**, 129-35.
126. DANIELS, H. E. & KENDALL, M. G. (1947), "The significance of rank correlations where parental correlation exists", *Biometrika*, **34**, 197-208.
127. FAN, K. (1944), "Conditions d'existence de suites illimitées d'événements correspondant à certaines probabilités données", *Rev. Rose Illus.*, **82**, 235-40.
128. FAN, K. (1944), "Un théorème général sur les probabilités associées à un système d'événements dépendants", *C. R. Acad. Sci. Paris*, **218**, 380-2.
129. GLEISSBERG, W. (1947), "Bedingungen für die Anordnung zufälliger Fehler", *Rev. Fac. Sci. Univ. Istanbul (A)*, **12**, 107-26.
130. GREENWOOD, J. A. (1943), "A preferential matching problem", *Psychometrika*, **8**, 185-91.
131. GREVILLE, T. N. E. (1944), "On multiple matching with one variable deck", *Ann. Math. Statist.*, **15**, 432-4.
132. GUTTMAN, L. (1946), "An approach for quantifying paired comparisons and rank order", *Ann. Math. Statist.*, **17**, 144-63.
133. HADEN, H. G. (1947), "A note on the distribution of the different orderings of n objects", *Proc. Camb. Phil. Soc.*, **43**, 1-9.
134. HADWIGER, H. (1943), "Gruppierung mit Nebenbedingungen", *Mitt. Ver. Schweiz. Versich.-Math.*, **43**, 113-22.
135. HÖFFDING, W. (1947), "On the distribution of the rank correlation coefficient τ when the variates are not independent", *Biometrika*, **34**, 183-96.
136. HSU, P. L., & CHUNG, K. L. (1946), "Sur un théorème de probabilités dénombrables", *C. R. Acad. Sci. Paris*, **223**, 467-9.
137. KAPLANSKY, I. (1943), "Solution of the 'problème des menages'", *Bull. Amer. Math. Soc.*, **49**, 784-5.
138. KAPLANSKY, I. (1944), "Symbolic solution of certain problems in permutations", *Bull. Amer. Math. Soc.*, **50**, 906-14.
139. KAPLANSKY, I. (1945), "The asymptotic distribution of runs of consecutive elements", *Ann. Math. Statist.*, **16**, 200-3.
140. KAPLANSKY, I. & RIORDAN, J. (1945), "Multiple matching and runs by the symbolic method", *Ann. Math. Statist.*, **16**, 272-7.
141. KENDALL, M. G. (1945), "The treatment of ties in ranking problems", *Biometrika*, **33**, 239-51.
142. KENDALL, M. G. (1947), "The variances of τ when both rankings contain ties", *Biometrika*, **34**, 297-8.
143. LINÉS ESCARDÓ, E. (1944), "Problems of coincidence. II", *Rev. Mat. Hisp. Amer.*, **4**, 188-205.

144. MORAN, P. A. P. (1947), "On the method of paired comparisons", *Biometrika*, **34**, 363-5.
145. NILSSEN, B. (1945), "Some remarks on counting", *Norsk Mat. Tidsskr.*, **27**, 106-11.
146. OLMSTEAD, P. S. (1946), "Distribution of sample arrangements for runs up and down", *Ann. Math. Statist.*, **17**, 24-33.
147. SCHÖBE, W. (1943), "Das Lucassche Ehepaarproblem", *Math. Z.*, **48**, 781-4.
148. SCHUTZENBERGER, M.P. (1947), "Sur certains paramètres caractéristiques des systèmes d'événements compatibles et dépendants et leur application au calcul des cumulants de la répétition", *C. R. Acad. Sci. Paris*, **225**, 277-8.
149. SILLITTO, G. P. (1947), "The distribution of Kendall's τ coefficient of rank correlation in rankings containing ties", *Biometrika*, **34**, 36-40.
150. SWED, F. S. & EISENHART, C. (1943), "Tables for testing randomness of grouping in a sequence of alternatives", *Ann. Math. Statist.*, **14**, 66-87.
151. VAJDA, S. (1946), "Average sampling numbers from finite lots", *J. R. Statist. Soc. Suppl.*, **8**, 198-201.
152. WALD, A. & WOLFOWITZ, J. (1944), "Statistical tests based on permutations of the observations", *Ann. Math. Statist.*, **15**, 358-72.
153. WHITFIELD, J. W. (1947), "Rank correlation between two variables, one of which is ranked, the other dichotomous", *Biometrika*, **34**, 292-6.
154. WOLFOWITZ, J. (1944), "Asymptotic distribution of runs up and down", *Ann. Math. Statist.*, **15**, 163-72.
155. WOLFOWITZ, J. (1944), "Note on runs of consecutive elements", *Ann. Math. Statist.*, **15**, 97-8.

3. DISTRIBUTION FUNCTIONS

3.1. Systems of Frequency Curves

156. CERNUSCHI, F. & CASTAGNETTO, L. (1947), "Probability schemes with contagion in space and time", *Ann. Math. Statist.*, **18**, 122-7.
157. CERNUSCHI, F. & CASTAGNETTO, L. (1946), "Chains of rare events", *Ann. Math. Statist.*, **17**, 53-61.
158. DELGLEIZE, A. (1943), "Sur les courbes de fréquence", *Bull. Soc. Roy. Sci. Liège*, **12**, 264-76.
159. FELLER, W. (1943), "On a general class of 'contagious' distributions", *Ann. Math. Statist.*, **14**, 389-400.
160. FORTET, R. (1944), "Calcul des moments d'une fonction de répartition à partir de sa caractéristique", *Bull. Sci. Math.*, **68**, 117-31.
161. GRIFFITH, L. (1943), "A theory of the size distribution of particles in a comminuted system", *Canadian J. Res. Sect. A*, **21**, 57-64.
162. HADWIGER, H. (1945), "Über Verteilungsgesetze vom Poissonschen Typus", *Mitt. Ver. Schweiz. Versich.-Math.*, **45**, 257-77.
163. KULLBACK, S. (1947), "On the Charlier type B series", *Ann. Math. Statist.*, **18**, 574-81.
164. RISSER, R. (1945), "Sur l'équation caractéristique des surfaces de probabilités", *C. R. Acad. Sci. Paris*, **220**, 31-2.
165. RISSER, R. (1945), "Sur le mode de tirages contagieux", *C. R. Acad. Sci. Paris*, **220**, 210-2.
166. RISSER, R. (1944), "Sur les courbes de distribution statistique", *C. R. Acad. Sci. Paris*, **219**, 505-7.
167. RISSER, R. (1944), "Étude spéciale du type de tirages de boules d'une urne, renfermant des boules de deux couleurs, dans l'hypothèse de non remise des boules après tirage", *C. R. Acad. Sci. Paris*, **219**, 541-2.
168. UVEN, M. J. VAN (1947), "Extension of Pearson's probability distributions to two variables. I, II", *Ned. Akad. Wet. Proc.*, **50**, 1063-70, 1252-64; *Indagationes Math.*, **9**, 477-84, 578-90.

3.2. Transformation of a Distribution Function: Moments, Cumulants, Characteristic Function, etc.

169. AROIAN, L. A. (1947), "Note on the cumulants of Fisher's z-distribution", *Biometrika*, **34**, 359-60.
170. BARTLETT, M. S. & KENDALL, D. G. (1946), "The statistical analysis of variance-heterogeneity and the logarithmic transformation", *J. R. Statist. Soc. Suppl.*, **8**, 128-38.
171. BHATTACHARYYA, A. (1946), "On a measure of divergence between two multinomial populations", *Sankhyā*, **7**, 401-6.
172. BHATTACHARYYA, A. (1943), "On a measure of divergence between two statistical populations defined by their probability distributions", *Bull. Calcutta Math. Soc.*, **35**, 99-109.
173. BIRNBAUM, Z. W., & ZUCKERMAN, H. S. (1944), "An inequality due to H. Hornich", *Ann. Math. Statist.*, **15**, 328-9.
174. BOLDRINI, M. (1946), "Sulla teoria della media tipica", *Pont. Acad. Sci. Comment.*, **10**, 1-41.
175. BOSWORTH, R. C. L. (1944), "Bessel's formula in relation to the calculation of the probable error from a small number of observations", *J. Roy. Soc. N.S.W.*, **78**, 81-3.
176. BRONOWSKI, J. & NEYMAN, J. (1945), "The variance of the measure of a two-dimensional random set", *Ann. Math. Statist.*, **16**, 330-41.
177. BROWN, L. M. (1944), "Some parameters of sampling distributions simply obtained", *Math. Notes Edin.*, **34**, 8-11.
178. CAMERON, R. H. & MARTIN, W. T. (1947), "The behaviour of measure and measurability under change of scale in Wiener space", *Bull. Amer. Math. Soc.*, **53**, 130-7.
179. CANSADO MACEDA, E. (1946), "Integral de Stieltjes-Lebesgue y sus Aplicaciones a la Estadística. (Stieltjes-Lebesgue integral and its applications to statistics)", *Mem. Mat. Inst. "Jorge Juan"*, **3**, 66.

180. CANSADO MACEDA, E. (1947), "Cumulants of Fisher's z ", *Rev. Mat. Hisp. Amer.*, 7, 87-9.
181. CHAKRABARTI, M. C. (1946), "The moments and semi-variants of the mean square successive difference", *Bull. Calcutta Math. Soc.*, 38, 185-9.
182. CHAKRABARTI, M. C. (1947), "On the inadequacy of measuring the peakedness of a distribution curve by the standardized fourth moment", *Bull. Calcutta Math. Soc.*, 39, 154-6.
183. CHENG, T-T. (1944), "A simplified formula for mean difference", *J. Amer. Statist. Ass.*, 39, 240-2.
184. CORNFIELD, J. (1944), "On samples from finite populations", *J. Amer. Statist. Ass.*, 39, 236-9.
185. DAVIES, G. R., and BRUNER, N. (1943), "A second moment correction for grouping", *J. Amer. Statist. Ass.*, 38, 63-8.
186. DYSON, F. J. (1943), "A note on kurtosis", *J. R. Statist. Soc.*, 106, 360-1.
187. EGUDIN, G. I. (1947), "Certain relations between the moments of the distribution of extreme values in random samples", *C. R. Acad. Sci. U.R.S.S. Doklady*, 58, 1581-4.
188. EGUDIN, G. I. (1947), "On the stability of some very general classes of statistics", *C. R. Acad. Sci. U.R.S.S. Doklady*, 57, 115-7.
189. EGUDIN, G. I. (1946), "On an effective method of calculation of the mathematical expectations of central sample moments", *C. R. Acad. Sci. U.R.S.S. Doklady*, 53, 487-90.
190. FINNEY, D. J. (1946), "The frequency distribution of deviates from means and regression lines in samples from a multivariate normal population", *Ann. Math. Statist.*, 17, 344-9.
191. FORTET, R. (1944), "Calcul des moments d'une fonction de répartition à partir de sa caractéristique", *Bull. Sci. Math.*, 68, 117-31.
192. FRAME, J. S. (1945), "Mean deviation of the binomial distribution", *Amer. Math. Mon.*, 52, 377-9.
193. FRÉCHET, M. (1946), "A general method of constructing correlation indices", *Proc. Math. Phys. Soc. Egypt*, 3, 13-20.
194. FRÉCHET, M. (1946), "Nouvelles définitions de la valeur moyenne et des valeurs équiprobables d'un nombre aléatoire", *Ann. Univ. Lyon, Sect. A*, 9, 5-26.
195. FRÉCHET, M. (1947), "Definition of the probable deviation", *Ann. Math. Statist.*, 18, 288-90.
196. FRÉCHET, M. (1947), "The general relation between the mean and mode for a discontinuous variate", *Ann. Math. Statist.*, 18, 290-3.
197. FRÉCHET, M. (1944), "Les systèmes d'événements et le jeu des rencontres", *Rev. Mat. Hisp. Amer.*, 4, 95-126.
198. FRÉCHET, M. (1947), "Anciens et nouveaux indices de corrélation. Leur application au calcul des retards économiques", *Econometrica*, 15, 1-30.
199. FRÉCHET, M. (1947), "Anciens et nouveaux indices de corrélation: errata", *Econometrica*, 15, 374-5.
200. GARWOOD, F. (1947), "The variance of the overlap of geometrical figures with reference to a bombing problem", *Biometrika*, 34, 1-17.
201. GEARY, R. C. & WORLLEDGE, J. P. G. (1947), "On the computation of universal moments of tests of statistical normality derived from samples drawn at random from a normal universe. Application to the calculation of the seventh moment of b_2 ", *Biometrika*, 34, 98-110.
202. GONTCHAROFF, W. (1943), "Sur la succession des événements dans une série d'épreuves indépendantes répondant au schéma de Bernoulli", *C. R. Acad. Sci. U.R.S.S. Doklady*, 38, 283-5.
203. GUMBEL, E. J. (1944), "Ranges and midranges", *Ann. Math. Statist.*, 15, 414-22.
204. HALDANE, J. B. S. (1945), "The use of χ^2 as a test of homogeneity in a $(n \times 2)$ -fold table when expectations are small", *Biometrika*, 33, 234-8.
205. HALDANE, J. B. S. (1945), "Moments of r and z^2 for a fourfold table in the absence of association", *Biometrika*, 33, 231-3.
206. HASTINGS, C., MOSTELLER, F., TUKEY, J. W., and WINSOR, C. P. (1947), "Low moments for small samples: A comparative study of order statistics", *Ann. Math. Statist.*, 18, 413-26.
207. HIRSCHMAN, A. O. (1943), "On measures of dispersion for a finite distribution", *J. Amer. Statist. Ass.*, 38, 236-52.
208. HIRSCHMAN, A. O. (1943), "On measures of dispersion for a finite distribution", *J. Amer. Statist. Ass.*, 38, 346-52.
209. HOEL, P. G. (1946), "The efficiency of the mean moving range", *Ann. Math. Statist.*, 17, 475-82.
210. HOEL, P. G. (1944), "On statistical coefficients of likeness", *Univ. Calif. Publ. Math.*, 2, 1-8.
211. HOEL, P. G. (1943), "On indices of dispersion", *Ann. Math. Statist.*, 14, 155-62.
212. HSU, L. C. (1944), "Some combinatorial formulas with applications to probable values of a polynomial product and to differences of zero", *Ann. Math. Statist.*, 15, 399-413.
213. HSU, L. C. (1945), "Some combinatorial formulas on mathematical expectation", *Ann. Math. Statist.*, 16, 369-80.
214. IRWIN, J. O. (1943), "A table of the variance of \sqrt{x} when x has a Poisson distribution", *J. R. Statist. Soc.*, 106, 143-4.
215. IRWIN, J. O. & KENDALL, M. G. (1944), "Sampling moments of moments for a finite population", *Ann. Eugen.*, 12, 138-42.
216. JONES, A. E. (1946), "A useful method for the routine estimation of dispersion from large samples", *Biometrika*, 33, 274-82.
217. KAC, M. (1943), "A correction to 'On the average number of real roots of a random algebraic equation'", *Bull. Amer. Math. Soc.*, 49, 938.
218. KAC, M. (1943), "On the average number of real roots of a random algebraic equation", *Bull. Amer. Math. Soc.*, 49, 314-20.
219. KAPLANSKY, I. (1945), "A common error concerning kurtosis", *J. Amer. Statist. Ass.*, 40, 259.
220. KHINTCHINE, A. (1943), "Sur un cas de corrélation a posteriori", *Mat. Sbornik*, 12, 185-95.

221. KNOLL, F. (1943), "Über Näherungsverfahren bei empirisch gegebenen Verteilungsfunktionen und damit verbundene Korrekturformeln", *Dische. Math.*, 7, 187-94.
222. LEIPNIK, R. B. (1947), "Distribution of the serial correlation coefficient in a circularly correlated universe", *Ann. Math. Statist.*, 18, 80-7.
223. LEVENE, H. & WOLFOWITZ, J. (1944), "The covariance matrix of runs up and down", *Ann. Math. Statist.*, 15, 58-69.
224. MCCARTHY, P. J. (1947), "Approximate solutions for means and variances in a certain class of box problems", *Ann. Math. Statist.*, 18, 349-83.
225. MICHALUP, E. (1946), "Über den Begriff 'Exzess' in der mathematischen Statistik", *Mitt. Ver. Schweiz. Versich.-Math.*, 46, 231-6.
226. MORRELL, A. J. H. (1944), "Note on Wilson and Hilferty's approximation to the χ^2 -distribution", *J. R. Statist. Soc.*, 107, 59.
227. MOURIER, E. (1946), "Étude du choix entre deux lois de probabilité", *C. R. Acad. Sci. Paris*, 223, 712-4.
228. MUNZER, H. (1947), "Eine wahrscheinlichkeitstheoretische Behandlung der Jokereibenschaft", *Z. Angew. Math. Mech.*, 25/27, 119-22.
229. NAIR, K. R. (1947), "A note on the mean deviation from the mean", *Biometrika*, 34, 360-2.
230. NEYMAN, J. (1946), "Un théorème d'existence", *C. R. Acad. Sci. Paris*, 222, 843-5.
231. ODHNOFF, W. (1946), "Some studies of the characteristic functions and the semi-invariants of Pearson's frequency-functions", *Fors.-Mat. Stud. Tillag. Fil. Lundberg*, 168-79.
232. ONICESCU, O. (1943), "Les structures planes", *Bull. Math. Soc. Roum. Sci.*, 45, 63-76.
233. ORTS, J. M. (1946), "A reciprocity property of the characteristic function", *Rev. Mat. Hisp.-Amer.*, 6, 43-7.
234. PILLAI, K. S. (1943), "A note on Poisson distribution", *Proc. Ind. Acad. Sci.*, 18, 179-89.
235. PLACKETT, R. L. (1947), "Limits of the ratio of mean range to standard deviation", *Biometrika*, 34, 120-2.
236. REIERSÖL, O. (1944), "Measures of departure from symmetry", *Skand. Aktuar. Tidskr.*, 27, 229-34.
237. ROBBINS, H. E. (1945), "On the measure of a random set. II", *Ann. Math. Statist.*, 16, 342-7.
238. ROBBINS, H. E. (1947), "Acknowledgment of priority", *Ann. Math. Statist.*, 18, 297.
239. ROBBINS, H. E. (1944), "On the expected values of two statistics", *Ann. Math. Statist.*, 15, 321-3.
240. ROBBINS, H. E. (1944), "On the measure of a random set", *Ann. Math. Statist.*, 15, 70-4.
241. ROY, S. N. (1947), "A note on critical angles between two flats in hyperspace with certain statistical application", *Sankhyā*, 8, 177-94.
242. SAMUELSON, P. A. (1943), "Fitting general Gram-Charlier series", *Ann. Math. Statist.*, 14, 179-87.
243. SANTALÓ, L. A. (1947), "On the first two moments of the measure of a random set", *Ann. Math. Statist.*, 18, 37-49.
244. SHOHAT, J. A. & TAMARKIN, J. D. (1943), "The problem of moments", *Amer. Math. Soc. Math. Surveys*, 2, xiv + 140 pp.
245. SIMAIKA, J. B. (1946), "Note on M. Fréchet's index of correlation", *Proc. Math. Phys. Soc. Egypt*, 3, 21-2.
246. STEPHAN, F. F. (1945), "The expected value and variance of the reciprocal and other negative powers of a positive Bernoullian variate", *Ann. Math. Statist.*, 16, 50-61.
247. SUKHATME, P. V. (1944), "Moments and product moments of moment-statistics for samples of finite and infinite populations", *Sankhyā*, 6, 363-82.
248. TUKEY, J. W. (1946), "An inequality for deviations from medians", *Ann. Math. Statist.*, 17, 75-8.
249. TUKEY, J. W. & WILKS, S. S. (1946), "Approximation of the distribution of the product of beta variables by a single beta variable", *Ann. Math. Statist.*, 17, 318-24.
250. VASWANI, S. P. (1947), "A pitfall in correlation theory", *Nature*, 160, 405-6.
251. VOTAW, D. F., Jr. (1946), "The probability distribution of the measure of a random linear set", *Ann. Math. Statist.*, 17, 240-4.
252. WHERRY, R. J. & TAYLOR, E. K. (1946), "The relation of multiseria eta to other measures of correlation", *Psychometrika*, 11, 155-61.
253. WILKINS, J. E., Jr. (1944), "A note on skewness and kurtosis", *Ann. Math. Statist.*, 15, 333-5.
254. WISHART, J. (1947), "The cumulants of the Z and of the logarithmic χ^2 and t distributions", *Biometrika*, 34, 170-8.
255. WISSEROTH, K. (1947), "Die günstigste Verteilungsbreite, ein neues Streuungsmass", *Z. Angew. Math. Mech.*, 25/27, 126-7.
256. WOLD, H. (1945), "A theorem on regression coefficients obtained from successively extended sets of variables", *Skand. Aktuar. Tidskr.*, 28, 181-200.
257. ZYGMUND, A. (1947), "A remark on characteristic functions", *Ann. Math. Statist.*, 18, 272-6.

3.3. Properties of Distribution Functions: including Limit Theorems and Convergence, Arithmetic of Distribution Functions and Regression Theory

258. BAER, R. (1945), "Sampling from a changing population", *Ann. Math. Statist.*, 16, 348-61.
259. BARTLETT, M. S. (1947), "The use of transformations", *Biometrika*, 3, 39-52.
260. BERGSTRÖM, H. (1945), "On the central limit theorem in the space R_k , $k > 1$ ", *Skand. Aktuar. Tidskr.*, 28, 106-27.
261. BERGSTRÖM, H. (1944), "On the central limit theorem", *Skand. Aktuar. Tidskr.*, 27, 139-53.
262. BERNSTEIN, S. N. (1943), "Retour au problème de l'évaluation de l'approximation de la formule limitée de Laplace", *Bull. Acad. Sci. U.R.S.S. Ser. Math.*, 7, 3-16.

1951]

263. BERNSTEIN, S. (1946), "Sur le théorème limite de la théorie des probabilités", *Bull. Math. Mech. Inst. Univ. Tomsk*, 3, 174-90.
264. BHATTACHARYYA, A. (1944), "On some sets of sufficient conditions leading to the normal bivariate distribution", *Sankhyā*, 6, 399-406.
265. BOBROFF, A. A. (1945), "Conditions of applicability of the strong law of large numbers", *Duke Math. J.*, 12, 43-6.
266. BOGOLYUBOV, N. N. (1945), "On certain limiting distributions for sums depending on arbitrary phases", *Uchen. Zap. Mosk. Univ. Fizika*, 77, 43-50.
267. BOREL, E. (1947), "Sur les développements unitaires normaux", *C. R. Acad. Sci. Paris*, 225, 51.
268. BROWN, G. W. & TUKEY, J. W. (1946), "Some distributions of sample means", *Ann. Math. Statist.*, 17, 1-12.
269. CHENG, T. T. (1943), "On the combination of statistical elements", *Coll. Pap. Sci. Engng. Nat. Univ. Amoy*, 1, 73-82.
270. CHUNG, K. (1947), "Note on some strong laws of large numbers", *Amer. J. Math.*, 69, 189-92.
271. CHUNG, K. L. (1947), "On the maximum partial sum of independent random variables", *Proc. Nat. Acad. Sci. Wash.*, 33, 132-6.
272. CHUNG, K. L., and ERDOS, P. (1947), "On the lower limit of sums of independent random variables", *Ann. Math.*, 48, 1003-13.
273. CRAIG, A. T. (1943), "Note on the independence of certain quadratic forms", *Ann. Math. Statist.*, 14, 195-7.
274. CRAIG, A. T. (1947), "Bilinear forms in normally correlated variables", *Ann. Math. Statist.*, 18, 565-73.
275. CURTISS, J. H. (1943), "Convergent sequences of probability distributions", *Amer. Math. Mon.*, 50, 94-105.
276. CURTISS, J. H. (1943), "On transformations used in the analysis of variance", *Ann. Math. Statist.*, 14, 107-22.
277. DALY, J. F. (1946), "On the use of the sample range in an analogue of Student's *t*-test", *Ann. Math. Statist.*, 17, 71-4.
278. DIEULEFAIT, C. (1943), "The multidimensional Gaussian distribution and its generalizations", *Ann. Soc. Cient. Argent.*, 136, 193-215.
279. DOEBLIN, W. (1947), "Sur l'ensemble de puissances d'une de probabilité", *Ann. Ecole Norm.*, 63, 317-50.
280. DOMB, C. (1946), "The resultant of a large number of events of random phase", *Proc. Camb. Phil. Soc.*, 42, 245-9.
281. ERDÖS, P., & KAC, M. (1947), "On the number of positive sums of independent random variables", *Bull. Amer. Math. Soc.*, 53, 1011-20.
282. ERDÖS, P., & KAC, M. (1946), "On certain limit theorems of the theory of probability", *Bull. Amer. Math. Soc.*, 52, 292-302.
283. ESSEEN, C. G. (1943), "Determination of the maximum deviation from the Gaussian law", *Ark. Mat. Astr. Fys.*, 29A, (20) 10.
284. FAN, K. (1944), "Sur l'extension de la formule générale d'interpolation de M. Borel aux fonctions aléatoires", *C. R. Acad. Sci. Paris*, 218, 260-2.
285. FELLER, W. (1945), "The fundamental limit theorems in probability", *Bull. Amer. Math. Soc.*, 51, 800-32.
286. FELLER, W. (1943), "The general form of the so-called law of the iterated logarithm", *Trans. Amer. Math. Soc.*, 54, 373-402.
287. FELLER, W. (1946), "The law of the iterated logarithm for identically distributed random variables", *Ann. Math.*, 47, 631-8.
288. FELLER, W. (1943), "Generalization of a probability limit theorem of Cramer", *Trans. Amer. Math. Soc.*, 54, 361-72.
289. FELLER, W. (1946), "A limit theorem for random variables with infinite moments", *Amer. J. Math.*, 68, 257-62.
290. FERRAND, J., & FORTET, R. (1947), "Sur des suites arithmétiques équiréparties", *C. R. Acad. Sci. Paris*, 224, 516-8.
291. FORSYTHE, G. E. (1943), "Cesàro summability of independent random variables", *Duke Math. J.*, 10, 397-428.
292. GEARY, R. C. (1943), "Minimum range for quasi-normal distributions", *Biometrika*, 33, 100-3.
293. GHOSH, M. N. (1946), "On the order of approximation involved in Laplace's central limit theorem in probability", *Sankhyā*, 7, 323-6.
294. GNEDENKO, B. V. (1944), "Limit theorems for sums of independent random variables", *Usp. Mat. Nauk.*, 10, 115-65.
295. GNEDENKO, B. (1943), "Sur la distribution limite du terme maximum d'une série aléatoire", *Ann. Math.*, 44, 423-53.
296. GUMBEL, E. J. (1946), "On the independence of the extremes in a sample", *Ann. Math. Statist.*, 17, 78-81.
297. HOTELLING, H. (1944), "Note on a matrix theorem of A. T. Craig", *Ann. Math. Statist.*, 15, 427-9.
298. HSU, P. L., & ROBBINS, H. (1947), "Complete convergence and the law of large numbers", *Proc. Nat. Acad. Sci. Wash.*, 33, 25-31.
299. KAC, M. (1942), "Note on the partial sums of the exponential series", *Univ. Nac. Tucumán. Rev. A.*, 3, 151-3.

300. KAC, M. (1945), "A remark on independence of linear and quadratic forms involving independent Gaussian variables", *Ann. Math. Statist.*, **16**, 400-1.
301. KAPLANSKY, I. (1943), "A characterization of the normal distribution", *Ann. Math. Statist.*, **14**, 197-8.
302. KAWATA, T. (1944), "The distribution of grouped moments in large samples", *Proc. Imp. Acad. Japan*, **20**, 337-9.
303. KIMBALL, B. F. (1944), "Note on asymptotic value of probability distribution of sum of random variables which are greater than a set of arbitrarily chosen numbers", *Ann. Math. Statist.*, **15**, 423-7.
304. KOSAMBI, D. D. (1946), "The law of large numbers", *Math. Student*, **14**, 14-9.
305. KOZAKIEWICZ, W. (1947), "On the convergence of sequences of moment generating functions", *Ann. Math. Statist.*, **18**, 61-9.
306. KUNISAWA, K. (1944), "Mean concentration function and the law of large numbers", *Proc. Imp. Acad. Japan*, **20**, 627-30.
307. LÉVY, P. (1947), "Remarques sur un théorème de M. Émile Borel", *C. R. Acad. Sci. Paris*, **225**, 918-9.
308. LINNIK, U. V. (1947), "On the accuracy of the approximation to the Gauss distribution by sums of independent variables", *Bull. Acad. Sci. U.R.S.S. Ser. Math.*, **11**, 111-38.
309. LINNIK, U. V. (1947), "On the accuracy of the approximation of the Gaussian distribution by sums of independent random variables", *C. R. Acad. Sci. U.R.S.S. Doklady*, **55**, 571-3.
310. LOÈVE, M. (1945), "Nouvelles classes de lois limites", *Bull. Soc. Math. Fr.*, **73**, 107-26.
311. LOÈVE, M. (1946), "Remarques sur les ensembles de lois", *C. R. Acad. Sci. Paris*, **222**, 628-30.
312. LOÈVE, M. (1945), "Étude asymptotique des sommes de variables aléatoires liées", *J. Math. Pures Appl.*, **24**, 249-318.
313. MANN, H. B., & WALD, A. (1943), "On stochastic limit and order relationships", *Ann. Math. Statist.*, **14**, 217-26.
314. MISES, R. v. (1947), "On the asymptotic distribution of differentiable statistical functions", *Ann. Math. Statist.*, **18**, 309-48.
315. ORTS ARACIL, J. M. (1943), "On the behaviour of certain probabilities", *Rev. Mat. Hisp.-Amer.*, **3**, 157-63.
316. ORTS, J. M. (1944), "Convergence of some mean values", *Rev. Mat. Hisp.-Amer.*, **4**, 127-30.
317. OSTROWSKI, A. (1946), "Sur la formule de Moivre-Laplace", *C. R. Acad. Sci. Paris*, **223**, 1090-2.
318. POMPILI, G. (1946), "Sulla regresione", *Univ. Roma. Ist. Naz. Alta Mat. Rend.*, **5**, 186-219.
319. RAO, C. R. (1946), "On the mean conserving property", *Proc. Ind. Acad. Sci. Sect. A*, **23**, 165-73.
320. RAO, C. R. (1947), "Note on a problem of Ragnar Frisch", *Econometrica*, **15**, 245-9.
321. ROBBINS, H. (1944), "On distribution-free tolerance limits in random sampling", *Ann. Math. Statist.*, **15**, 214-6.
322. ROBBINS, H. (1946), "On the (C,1) summability of certain random sequences", *Bull. Amer. Math. Soc.*, **52**, 699-703.
323. ROSENBLATT, A. (1945), "On the strong law of large numbers", *Act. Acad. Ci. Lima*, **8**, 7-26.
324. ROY, S. N. & BOSE, P. (1945), "Bernoulli's theorem and Tchebycheff's analogue", *Sankya*, **7**, 209-10.
325. SARMANOV, O. (1945), "On isogeneous correlation", *Bull. Acad. Sci. U.R.S.S. Ser. Math.*, **9**, 169-200.
326. SARMANOV, O. V. (1947), "Generalization of a limit theorem of the theory of probability to sums of almost independent variables satisfying Lindeberg's condition", *Bull. Acad. Sci. U.R.S.S. (Izvestiya) Ser. Mat.*, **11**, 569-575.
327. SCHEFFÉ, H. (1947), "A useful convergence theorem for probability distributions", *Ann. Math. Statist.*, **18**, 434-8.
328. SCHULZ, G. (1947), "Das Summenproblem bei mehrdimensionalen arithmetischen Wahrscheinlichkeitsverteilungen", *Ber. Math. Tagung Tübingen*, 1946, 131-4.
329. SMITH, J. C. (1945), "Asymptotic distribution of sums of Rademacher functions", *Bull. Amer. Math. Soc.*, **51**, 941-4.
330. TWEEDIE, M. C. K. (1946), "The regression of the sample variance on the sample mean", *J. Lond. Math. Soc.*, **21**, 22-8.
331. WALD, A. (1947), "Limit distribution of the maximum and minimum of successive cumulative sums of random variables", *Bull. Amer. Math. Soc.*, **53**, 142-53.
332. WEI, D. S. (1943), "Necessary and sufficient conditions that regression systems of sums with elements in common be linear", *Nat. Math. Mag.*, **17**, 151-8.
333. WINTNER, A. (1947), "On the shape of the angular case of Cauchy's distribution curves", *Ann. Math. Statist.*, **18**, 589-93.
334. WOLD, H. (1946), "A comment on spurious correlation", *Forsmat. Stud. Tilläg. Fil. Lundberg, Stockholm*, 278-85.

3.4. Evaluation of Particular Distribution Functions: Transformation of Variates

335. ANDERSON, T. W. (1946), "The non-central Wishart distribution and certain problems of multivariate statistics", *Ann. Math. Statist.*, **17**, 409-31.
336. ANDERSON, T. W. & GIRSHICK, M. A. (1944), "Some extensions of the Wishart distribution", *Ann. Math. Statist.*, **15**, 345-57.
337. AROIAN, L. A. (1943), "A new approximation to the levels of significance of the chi-square distribution", *Ann. Math. Statist.*, **14**, 93-5.
338. AROIAN, L. A. (1947), "The probability function of the product of two normally distributed variables", *Ann. Math. Statist.*, **18**, 265-71.

1951]

339. BAKER, G. A. (1946), "Distribution of the ratio of sample range to sample standard deviation for normal and combinations of normal distributions", *Ann. Math. Statist.*, 17, 366-9.
340. BARTLETT, M. S. (1947), "The general canonical correlation distribution", *Ann. Math. Statist.*, 18, 1-17.
341. BAZALAR, T. N. (1945), "On the law of large numbers of the theory of probability", *Rev. Cienc. Lima*, 47, 601-43.
342. BHATTACHARYA, A. (1945), "A note on the distribution of the sum of chi-squares", *Sankhyā*, 7, 27-8.
343. BIRNBAUM, Z. W. (1946), "Tchebysheff inequality for two dimensions", *Bull. Amer. Math. Soc.*, 52, 621.
344. BIRNBAUM, Z. W., RAYMOND, J., and ZUCKERMAN, H. S. (1947), "A generalization of Tschebyshev's inequality to two dimensions", *Ann. Math. Statist.*, 18, 70-9.
345. BOSE, P. K. (1947), "Parametric relations in multivariate distributions", *Sankhyā*, 8, 167-71.
346. CAMP, B. H. (1946), "The effect on a distribution function of small changes in the population function", *Ann. Math. Statist.*, 17, 226-31.
347. CARTER, A. H. (1947), "Approximation to percentage points of the z distribution", *Biometrika*, 34, 352-8.
348. CHAKRABARTI, M. C. (1947), "On a special case of the distribution law of the mean square successive difference", *Bull. Calcutta Math. Soc.*, 39, 15-8.
349. CHENG, T. T. (1944), "A new probability function and its properties", *J. Amer. Statist. Ass.*, 39, 243-5.
350. CHERIYAN, K. C. (1945), "Distributions of certain frequency constants in samples from non-normal populations", *Sankhyā*, 7, 159-66.
351. CHUNG, K. L. (1946), "The approximate distribution of Student's statistic", *Ann. Math. Statist.*, 17, 447-65.
352. DANIELS, H. E. (1945), "The statistical theory of the strength of bundles of threads. I", *Proc. Roy. Soc. Lond., Ser. A*, 183, 405-35.
353. DIXON, W. J. & MOOD, A. M. (1946), "The statistical sign test", *J. Amer. Statist. Ass.*, 41, 557-66.
354. ELFVING, G. (1947), "A simple method of deducing certain distributions connected with multivariate sampling", *Skand. Aktuar. Tidskr.*, 30, 56-74.
355. ELFVING, G. (1947), "The asymptotical distribution of range in samples from a normal population", *Biometrika*, 34, 111-9.
356. FELLER, W. (1945), "On the normal approximation to the binomial distribution", *Ann. Math. Statist.*, 16, 319-29.
357. FRANCHETTI, S. (1943), "Probabilità di errore nelle distribuzioni di Poisson", *Pont. Acad. Sci. Comment.*, 7, 697-708.
358. FURRY, W. H. & HURWITZ, H. (1945), "Distribution of numbers and distribution of significant figures", *Nature*, 155, 52-3.
359. GADDUM, J. H. (1945), "Lognormal distributions", *Nature*, 156, 463-6.
360. GADDUM, J. H., ALLEN, P., and PEARCE, S. C. (1945), "Lognormal distributions", *Nature, Lond.*, 156, 462-6; 746-7.
361. GEARY, R. C. (1947), "The frequency distribution of $\sqrt{b_1}$ for samples of all sizes drawn at random from a normal population", *Biometrika*, 34, 68-97.
362. GEORGE, A. (1945), "On the accuracy of the different approximations to the L_1 -distribution", *Sankhyā*, 7, 20-6.
363. GODDARD, L. S. (1945), "The accumulation of chance effects and the Gaussian frequency distribution", *Phil. Mag.*, 36, 428-33.
364. GODWIN, H. J. (1945), "On the distribution of the estimate of mean deviation obtained from samples from a normal population", *Biometrika*, 33, 254-6.
365. GOLDBERG, H. & LEVINE, H. (1946), "Approximate formulas for the percentage points and normalization of t and χ^2 ", *Ann. Math. Statist.*, 17, 216-25.
366. GOUDSMIT, S. A., & FURRY, W. H. (1944), "Significant figures of numbers in statistical tables", *Nature*, 154, 800-1.
367. GRUBBS, F. E. (1944), "On the distribution of the radial standard deviation", *Ann. Math. Statist.*, 15, 75-81.
368. GUMBEL, E. J. (1947), "The distribution of the range", *Ann. Math. Statist.*, 18, 384-412.
369. GUMBEL, E. J. (1947), "The asymptotic distribution of the range", *Bull. Amer. Math. Soc.*, 53, 68.
370. HALD, A., & RASCH, G. (1943), "Some applications of methods of transformation in the normal distribution theory", *Festskrift til J. F. Steffensen*, 52-65.
371. HALD, A., & RASCH, G. (1943), "Some applications of methods of transformation in the normal distribution theory", *Festskrift til Professor, Danske Aktuar, Copenhagen*.
372. HALDANE, J. B. S. (1945), "Chance effects and the Gaussian distribution", *Phil. Mag.*, 36, 184-5.
373. HARTLEY, H. O. & KHAMIS, S. H. (1947), "A numerical solution of the problem of moments", *Biometrika*, 34, 340-51.
374. HARTLEY, H. O. (1944), "Studentization or the elimination of the standard deviation of the parent population from the random sample-distribution of statistics", *Biometrika*, 33, 173-80.
375. HARTLEY, H. O. (1945), "Note on the calculation of the distribution of the estimate deviation in normal samples", *Biometrika*, 33, 257-8.
376. HORNER, F. (1946), "A problem on the summation of simple harmonic functions of the same amplitude and frequency but of random phase", *Phil. Mag.*, 37, 145-62.

377. HOYT, R. S. (1947), "Probability functions for the modulus and angle of the normal complex variate", *Bell. Syst. Tech. J.*, **26**, 318-59.
378. HSU, P. L. (1945), "The approximate distributions of the mean and variance of a sample of independent variables", *Ann. Math. Statist.*, **16**, 1-29.
379. HSU, P. L. (1945), "On the approximate distribution of ratios", *Ann. Math. Statist.*, **16**, 204-10.
380. HSU, P. L. (1946), "On the asymptotic distributions of certain statistics used in testing the independence between successive observations from a normal population", *Ann. Math. Statist.*, **17**, 350-4.
381. JORDAN, C. (1946), "Complément au théorème de Simmons sur les probabilités", *Acta Univ. Szeged. Sect. Sci. Math.*, **11**, 19-27.
382. KOSAMBI, D. D. (1944), "The geometric method in mathematical statistics", *Amer. Math. Mon.*, **51**, 382-9.
383. KOSAMBI, D. D. (1944), "The geometric method in mathematical statistics", *Amer. Math. Mon.*, **51**, 382-9.
384. KRISHNA SASTRY, K. V. (1946), "On a certain distribution in the theory of sampling", *Proc. Nat. Inst. Sci. India*, **12**, 427-8.
385. KRUSKAL, W. (1946), "Helmert's distribution", *Amer. Math. Mon.*, **53**, 435-8.
386. LEIPNIK, R. B. (1947), "Distribution of the serial correlation coefficient in a circularly correlated universe", *Ann. Math. Statist.*, **18**, 80-7.
387. LITTLEWOOD, J. E. & OFFORD, A. C. (1943), "On the number of real roots of a random algebraic equation III", *Mat. Sbornik*, **12**, 277-86.
388. LORD, E. (1947), "The use of range in place of standard deviation in the *t*-test", *Biometrika*, **34**, 41-67.
389. MADOW, W. G. (1945), "Note on the distribution of the serial correlation coefficient", *Ann. Math. Statist.*, **16**, 308-10.
390. MARTIN, D. (1946), "On the radial error in a Gaussian elliptical scatter", *Phil. Mag.*, **37**, 635-9.
391. MAURIN, J. (1947), "Un mode de calcul général de la fonction de probabilité de moyennes", *C. R. Acad. Sci. Paris*, **225**, 1268-9.
392. OBERG, E. N. (1947), "Approximate formulae for the radii of circles which include a specified fraction of a normal bivariate distribution", *Ann. Math. Statist.*, **18**, 442-7.
393. OFFORD, A. C. (1945), "An equality for sums of independent random variables", *Proc. Lond. Math. Soc.*, **48**, 467-77.
394. PARKER, J. B. (1947), "The accumulation of chance effects and the Gaussian frequency distribution", *Phil. Mag.*, **38**, 681-2.
395. PEISER, A. M. (1943), "Asymptotic formulas for significance levels of certain distributions", *Ann. Math. Statist.*, **14**, 56-62.
396. PILLAI, K. C. S. (1946), "Confidence interval for the correlation coefficient", *Sankhyā*, **7**, 415-22.
397. QUENSEL, C. E. (1943), "An extension of the validity of 'Student'-Fisher law of distribution", *Skand. Aktuar. Tidskr.*, **26**, 210-9.
398. QUENSEL, C. E. (1947), "The validity of the *z*-criterion when the variates are taken from different normal populations", *Skand. Aktuar. Tidskr.*, **30**, 44-55.
399. RAO, C. R. (1946), "Tests with discriminant functions in multivariate analysis", *Sankhyā*, **7**, 407-14.
400. RAJALAKSHMAN, D. V. (1943), "On the interval between the ranked individuals of samples taken from a rectangular population", *J. Madras Univ. Sect.*, **B**, **15**, 31-44.
401. ROY, S. N. (1946), "Multivariate analysis of variance: the sampling distribution of the numerically largest of the *p*-statistics on the non-null hypothesis", *Sankhyā*, **8**, 15-52.
402. ROY, S. N. (1945), "The individual sampling distribution of the maximum, the minimum and any intermediate of the *p*-statistics on the null-hypothesis", *Sankhyā*, **7**, 133-158.
403. ROY, S. N. (1946), "A note on multi-variate analysis of variance when the number of variates is greater than the number of linear hypotheses per character", *Sankhyā*, **8**, 53-66.
404. RUBIN, H. (1945), "On the distribution of the serial correlation coefficient", *Ann. Math. Statist.*, **16**, 211-5.
405. SAKAMOTO, H. (1943), "On the distributions of the product and the quotient of the independent and uniformly distributed random variables", *Tohoku Math. J.*, **49**, 243-60.
406. SAWKINS, D. T. (1947), "A new method of approximating the binomial and hypergeometric probabilities", *J. Roy. Soc. N.S.W.*, **81**, 38-47.
407. SILBERSTEIN, L. (1944), "The accumulation of chance effects and the Gaussian frequency distribution", *Phil. Mag.*, **35**, 395-404.
408. SIMPSON, H. (1943), "On a theorem concerning sampling", *J. R. Statist. Soc.*, **106**, 266-7.
409. SKELLAM, J. G. (1946), "The frequency distribution of the difference between two Poisson variates belonging to different populations", *J. R. Statist. Soc.*, **109**, 296.
410. SLACK, M. (1946), "The probability distributions of sinusoidal oscillations combined in random phase", *J. Instn. Elect. Engrs.*, **93**, 76-86.
411. SUN, S. P. (1945), "On the successive approximation to the distribution of the third moment about the mean of independent variates", *Acad. Sinica Sc. Rec.*, **1**, 351-4.
412. SUN, S. P. (1943), "The approximate distribution of the *k*th moment about the mean of large samples", *Acad. Sinica Sci. Rec.*, **2**.
413. SVERDRUP, E. (1947), "Derivation of the Wishart distribution of the second order sample moments by straightforward integration of a multiple integral", *Skand. Aktuar. Tidskr.*, **30**, 151-66.
414. THOMSON, D. H. (1947), "Approximate formulae for the percentage points of the incomplete beta function and of the χ^2 distribution", *Biometrika*, **34**, 368-72.

1951]

415. VOTAW, D. F. (1946), "The probability distribution of the measure of a random linear set", *Ann. Math. Statist.*, **17**, 240-4.
416. WALSH, J. E. (1946), "Some order statistic distributions for samples of size four", *Ann. Math. Statist.*, **17**, 246-8.
417. WALSH, J. E. (1947), "Concerning the effect of intraclass correlation on certain significance tests", *Ann. Math. Statist.*, **18**, 88-96.
418. WEAVER, C. L. (1947), "A simple analytic proof of a general theorem", *Amer. Math. Mon.*, **54**, 529-33.
419. WELCH, B. L. (1947), "On the Studentization of several variances", *Ann. Math. Statist.*, **18**, 118-22.
420. WELCH, B. L. (1947), "The generalization of 'Student's' problem when several different population variances are involved", *Biometrika*, **34**, 28-35.
421. WELKER, E. L. (1947), "The distribution of the mean", *Ann. Math. Statist.*, **18**, 111-7.
422. WILLIAMS, J. D. (1946), "An approximation to the probability integral", *Ann. Math. Statist.*, **17**, 363-5.
423. WINSTEN, C. B. (1946), "Inequalities in terms of mean range", *Biometrika*, **33**, 283-95.
424. WISHART, J. (1947), "Proof of the distributions of χ^2 , of the estimate of variance, and of the variance ratio", *J. Inst. Actu. Stud. Soc.*, **7**, 98-103.

•3.5. Tables

425. BALDWIN, E. M. (1946), "Table of percentage points of the t -distribution", *Biometrika*, **33**, 362.
426. BLISS, C. I. (1944), "A chart of the chi-square distribution", *J. Amer. Statist. Ass.*, **39**, 246-8.
427. BOWKER, A. H. (1946), "Computation of factors for tolerance limits on a normal distribution when the sample is large", *Ann. Math. Statist.*, **17**, 238-40.
428. CROW, J. F. (1945), "A chart of the χ^2 and t distributions", *J. Amer. Statist. Ass.*, **40**, 376.
429. FERRIS, C. D., GRUBBS, E. & WEAVER, C. L. (1946), "Operating characteristics for the common statistical tests of significance", *Ann. Math. Statist.*, **17**, 178-97.
430. FRANCIS, V. J. (1946), "On the distribution of the sum of n sample values drawn from a truncated normal population", *J. R. Statist. Soc. Suppl.*, **8**, 223-32.
431. GILDEMEISTER, M. & VAN DER WAERDEN, B. L. (1944), "Die Zulässigkeit des χ^2 -Kriteriums für kleine Versuchszahlen", *Ber. Verh. Sächs. Akad. Wiss. Leipzig. Math.-Nat. Kl.*, **95**, 145-50.
432. HARTLEY, H. O. (1945), "Tables of the probability integral of the mean deviation in normal samples", *Biometrika*, **33**, 259-65.
433. HARTLEY, H. O., PEARSON, E. S., THOMPSON, C. M. & MERRINGTON, M. (1946), "Tables for testing the homogeneity of a set of estimated variances", *Biometrika*, **33**, 296-304.
434. HAYES, S. P., Jr. (1946), "Diagrams for computing tetrachoric correlation coefficients from percentage differences", *Psychometrika*, **11**, 163-72.
435. HAYES, S. P., Jr. (1943), "Tables of the standard error of tetrachoric correlation coefficient", *Psychometrika*, **8**, 193-203.
436. JURGENSEN, C. E. (1947), "Table for determining phi coefficients", *Psychometrika*, **12**, 17-29.
437. LEHMÉR, E. (1944), "Inverse tables of probabilities of errors of the second kind", *Ann. Math. Statist.*, **15**, 388-98.
438. LEVERETT, H. M. (1947), "Table of mean deviates for various portions of the unit normal distribution", *Psychometrika*, **12**, 141-52.
439. MOLINA, E. C. (1946), "Some fundamental curves for the solution of sampling problems", *Ann. Math. Statist.*, **17**, 325-35.
440. NICHOLSON, C. (1943), "The probability integral for two variables", *Biometrika*, **33**, 59-72.
441. PEARSON, E. S. & HARTLEY, H. O. (1943), "Tables of the probability integral of the Studentized range", *Biometrika*, **33**, 89-99.
442. WILSON, E. B. & WORCESTER, J. (1943), "A table determining L.D.50 or the fifty per cent. end point", *Proc. Nat. Acad. Sci. Wash.*, **29**, 207-12.

4. SAMPLING THEORY

443. SCHEFFÉ, H. (1943), "Statistical inference in the non-parametric case", *Ann. Math. Statist.*, **14**, 305-32.

4.1. Choice of Distribution Curve

444. DAVID, F. N. (1947), "A χ^2 'smooth' test for goodness of fit", *Biometrika*, **34**, 299-310.
445. GUMBEL, E. J. (1943), "On the reliability of the classical chi-square test", *Ann. Math. Statist.*, **14**, 253-63.
446. MALMQUIST, K. G. (1943), "On some formulas for the computation of space densities", *Ark. Mat. Astr. Fys.*, **29B**, (8), 7.
447. SICHEL, H. S. (1947), "Fitting growth and frequency curves by the method of frequency moments", *J. R. Statist. Soc.*, **110**, 337-47.
448. VATNSDAL, J. R. (1946), "Minimal variance and its relation to efficient moment tests", *Ann. Math. Statist.*, **17**, 198-207.
449. VILLE, J. (1944), "Sur la transitivité d'une methode d'estimation", *Ann. Univ. Lyon Sect. A*, **7**, 14-20.

4.2. Theory of Significance Tests

450. BARNARD, G. A. (1947), "The meaning of a significance level", *Biometrika*, **34**, 179-82.
451. BROOKNER, R. J. (1945), "Choice of one among several statistical hypotheses", *Ann. Math. Statist.*, **16**, 221-42.

452. CHAMBERLIN, T. C. (1944), "The method of multiple working hypotheses", *Sci. Mon.*, N.Y., 59, 357-62.
453. COURT, L. M. (1944), "A reciprocity principle for the Neyman-Pearson theory of testing statistical hypotheses", *Ann. Math. Statist.*, 15, 326-7.
454. FISHER, R. A. (1945), "The logical inversion of the notion of the random variable", *Sankhyā*, 7, 129-32.
455. GIRSHICK, M. A. (1946), "Contributions to the theory of sequential analysis. I", *Ann. Math. Statist.*, 17, 123-43.
456. GIRSHICK, M. A. (1946), "Contributions to the theory of sequential analysis. II, III", *Ann. Math. Statist.*, 17, 282-98.
457. KAPLANSKY, J. (1945), "A contribution to Von Neumann's theory of games", *Ann. Math.*, 46, 474-9.
458. LEHMANN, E. L. (1947), "On optimum tests of composite hypotheses with one constraint", *Ann. Math. Statist.*, 18, 473-94.
459. LEHMANN, E. (1946), "Une propriété optimale de certains ensembles critiques du type A", *C. R. Acad. Sci. Paris*, 223, 567-9.
460. LEHMANN, E. L. (1947), "On families of admissible tests", *Ann. Math. Statist.*, 18, 97-104.
461. LEHMANN, E. L. & SCHEFFE, H. (1947), "On the problem of similar regions", *Proc. Nat. Acad. Sci. Wash.*, 33, 382-6.
462. MISES, R. VON (1943), "On the problem of testing hypotheses", *Ann. Math. Statist.*, 14, 238-52.
463. NANDI, H. K. (1946), "On the average power of test criteria", *Sankhyā*, 8, 67-72.
464. PAULSON, E. (1947), "A note on the efficiency of the Wald sequential test", *Ann. Math. Statist.*, 18, 447-50.
465. RAO, C. R. & POTI, S. J. (1946), "On locally most powerful tests when alternatives are one-sided", *Sankhyā*, 7, 439.
466. ROY, S. N. (1947), "Notes on testing of composite hypotheses", *Sankhyā*, 8, 257-70.
467. SCHEFFÉ, H. (1943), "On a measure problem arising in the theory of non-parametric tests", *Ann. Math. Statist.*, 14, 227-33.
468. WALD, A. (1943), "Tests of statistical hypotheses concerning several parameters when the number of observations is large", *Trans. Amer. Math. Soc.*, 54, 426-82.
469. WALD, A. (1945), "Statistical decision functions which minimize the maximum risk", *Ann. Math.*, 46, 265-80.
470. WALD, A. (1945), "Generalisation of a theorem by v. Neumann concerning zero sum two person games", *Ann. Math.*, 46, 281-6.
471. WALD, A. (1947), "Foundations of a general theory of sequential decision functions", *Econometrica*, 15, 279-313.
472. WALD, A. (1947), "An essentially complete class of admissible decision functions", *Ann. Math. Statist.*, 18, 549-55.
473. WALD, A. (1945), "Sequential tests of statistical hypotheses", *Ann. Math. Statist.*, 16, 117-86.

4.3. Theory of Estimation

474. ALLARD, G. (1947), "Détermination de la valeur la plus probable des grandeurs statistiques. I. Généralités", *J. Phys. Radium*, 8, 212-4.
475. BHATTACHARYYA, A. (1946), "On some analogues of the amount of information and their use in statistical estimation", *Sankhyā*, 8, 1-14.
476. BHATTACHARYYA, A. (1947), "On some analogues of the amount of information and their use in statistical estimation. II", *Sankhyā*, 8, 201-18.
477. BLACKWELL, D. (1947), "Conditional expectation and unbiased sequential estimation", *Ann. Math. Statist.*, 18, 105-10.
478. BROWN, G. W. (1947), "On small-sample estimation", *Ann. Math. Statist.*, 18, 582-5.
479. CRAIG, A. T. (1943), "A note on the best linear estimate", *Ann. Math. Statist.*, 14, 88-90.
480. CRAMÉR, H. (1946), "A contribution to the theory of statistical estimation", *Skand. Aktuar. Tidskr.*, 29, 85-94.
481. DARMOIS, G. (1946), "Sur certaines lois de probabilité", *C. R. Acad. Sci. Paris*, 222, 164-5.
482. DARMOIS, G. (1946), "Résumés exhaustifs et problème du Nil", *C.R. Acad. Sci. Paris*, 222, 266-8.
483. DUMAS, M. (1947), "Sur une loi de probabilité à priori conduisant aux arguments fiduciaires de Fisher", *Rev. Sci.*, 85, 3-18.
484. FERAUD, L. (1946), "Sur les distributions à projection indépendante du paramètre", *C. R. Acad. Sci. Paris*, 222, 1272-3.
485. FRÉCHET, M. (1946), "Fondements des méthodes statistiques d'estimation", *Portugaliae Math.*, 5, 137-41.
486. GEARY, R. C. (1944), "Comparison of the concepts of efficiency and closeness for consistent estimates of a parameter", *Biometrika*, 33, 123-8.
487. GEPPERT, M. P. (1947), "Mutungsgrenzen und Mutungswahrscheinlichkeit", *Z. Angew. Math. Mech.*, 25/27, 253-63.
488. HALMOS, P. R. (1946), "The theory of unbiased estimation", *Ann. Math. Statist.*, 17, 34-43.
489. JEFFREYS, H. (1946), "An invariant form for the prior probability in estimation problems", *Proc. Roy. Soc. Lond.*, 186, 453-61.
490. KENDALL, D. G. (1946), "Fisher's 'Problem of the Nile'", *Nature, Lond.*, 158, 452.
491. KIMBALL, B. F. (1946), "Sufficient statistical estimation functions for the parameters of the distribution of maximum values", *Ann. Math. Statist.*, 17, 299-309.

1951]

492. LANDAU, H. G. (1944), "Note on the variance and best estimates", *Ann. Math. Statist.*, **15**, 219-21.
 493. RAO, C. R. (1946), "Minimum variance and the estimation of several parameters", *Proc. Camb. Phil. Soc.*, **43**, 280-3.
 494. RAO, C. R. (1945), "Information and the accuracy attainable in the estimation of statistical parameters", *Bull. Calcutta Math. Soc.*, **37**, 81-91.
 495. SCHEFFÉ, H. & TUKEY, J. W. (1945), "Non-parametric estimation. I. Validation of order statistics", *Ann. Math. Statist.*, **16**, 187-92.
 496. SOLOMON, L. (1948), "Statistical estimation", *J. Inst. Actu. Stud. Soc.*, **7**, 144-73, 213-34.
 497. TWEEDIE, M. C. K. (1947), "Functions of a statistical variate with given means, with special reference to Laplacian distributions", *Proc. Camb. Phil. Soc.*, **43**, 41-9.
 498. VILLE, J. (1944), "Sur la théorie invariante de l'estimation statistique", *Bull. Sci. Math.*, **68**, 95-108.
 499. WOLFOWITZ, J. (1947), "The efficiency of sequential estimates and Wald's equation for sequential processes", *Ann. Math. Statist.*, **18**, 215-30.

4.4. Design of Experiments and Sampling Techniques

500. BHATTACHARYA, K. N. (1943), "A note on two-fold triple systems", *Sankhyā*, **6**, 313-4.
 501. BHATTACHARYA, K. N. (1944), "A new balanced incomplete block design", *Science and Culture*, **9**, 508.
 502. BHATTACHARYA, K. N. (1944), "On a new symmetrical balanced incomplete block design", *Bull. Calcutta Math. Soc.*, **36**, 91-6.
 503. BHATTACHARYA, K. N. (1946), "A new solution in symmetrical balanced incomplete designs: $v = b = 31, r = k = 10, \lambda = 3$ ", *Sankhyā*, **7**, 423-4.
 504. BOSE, R. C. (1947), "Mathematical theory of the symmetrical factorial design", *Sankhyā*, **8**, 107-66.
 505. CHOWLA, S. (1944), "Contributions to the theory of the construction of balanced incomplete block designs", *Proc. Lahore Phil. Soc.*, **6**, 17-23.
 506. CHOWLA, S. (1945), "A contribution to the theory of the construction of balanced incomplete block designs", *Proc. Lahore Phil. Soc.*, **7**, 3 pp.
 507. CHOWLA, S. (1944), "A new case of a 'complete 1-m-n configuration'", *Proc. Lahore Phil. Soc.*, **6**, 13.
 508. CHOWLA, S. (1944), "Contribution to the theory of the construction of balanced incomplete block designs used in the statistical tables of Fisher and Yates", *Proc. Lahore Phil. Soc.*, **6**, 10-2.
 509. CHOWLA, S. (1944), "Another case of a 'complete 1-m-n configuration'", *Proc. Lahore Phil. Soc.*, **6**, 14.
 510. COCHRAN, W. G. (1946), "Relative accuracy of systematic and stratified random samples for a certain class of populations", *Ann. Math. Statist.*, **17**, 164-77.
 511. FINNEY, D. J. (1945), "Some orthogonal properties of the 4×4 and 6×6 Latin squares", *Ann. Eugen.*, **12**, 213-9.
 512. FINNEY, D. J. (1946), "Orthogonal partitions of the 5×5 Latin squares", *Ann. Eugen.*, **13**, 1-3.
 513. FINNEY, D. J. (1946), "Orthogonal partitions of the 6×6 Latin squares", *Ann. Eugen.*, **13**, 184-96.
 514. FINNEY, D. J. (1945), "The fractional replication of factorial arrangements", *Ann. Eugen.*, **12**, 291-301.
 515. FINNEY, D. J. (1946), "Recent developments in the design of field experiments. III. Fractional replication", *J. Agric. Sci.*, **36**, 63-8.
 516. FISHER, R. A. (1945), "A system of confounding for factors with more than two alternatives, giving completely orthogonal cubes and higher powers", *Ann. Eugen.*, **12**, 283-90.
 517. GHOSH, B. (1943), "On the construction of some natural fields", *Science and Culture*, **9**, 213-4.
 518. HALL, M. (1945), "An existence theorem for Latin squares", *Bull. Amer. Math. Soc.*, **51**, 387-8.
 519. HUSSAIN, Q. M. (1945), "On the totality of the solutions for the symmetrical incomplete block designs: $\lambda = 2, k = 5$ or 6 ", *Sankhyā*, **7**, 204-8.
 520. HUSSAIN, Q. M. (1946), "Impossibility of the symmetrical incomplete block design with $\lambda = 2, k = 7$ ", *Sankhyā*, **7**, 317-22.
 521. HUSSAIN, Q. M. (1945), "Symmetrical incomplete block designs with $\lambda = 2, k = 8$ or 9 ", *Bull. Calcutta Math. Soc.*, **37**, 115-23.
 522. JESSEN, A. (1945), "A combinatorial problem", *Mat. Tidsskr.*, **58**.
 523. KEMPTHORNE, O. (1947), "A simple approach to confounding and fractional replication in factorial experiments", *Biometrika*, **34**, 255-72.
 524. KERAWALA, S. M. (1946), "Note on the incomplete block designs: $\lambda = 2, k = 6$ or 7 ", *Bull. Calcutta Math. Soc.*, **38**, 190-2.
 525. MANN, H. B. (1944), "On orthogonal Latin squares", *Bull. Amer. Math. Soc.*, **50**, 249-57.
 526. MANN, H. B. (1943), "On the construction of sets of orthogonal Latin squares", *Ann. Math. Statist.*, **14**, 401-14.
 527. NAIR, K. R. (1943), "Certain inequality relationships among the combinatorial parameters of incomplete block designs", *Sankhyā*, **6**, 255-9.
 528. NANDI, H. K. (1945), "On the relation between certain types of tactical configurations", *Bull. Calcutta Math. Soc.*, **37**, 92-4.
 529. NANDI, H. K. (1946), "Enumeration of non-isomorphic solutions of balanced incomplete block designs", *Sankhyā*, **7**, 305-12.
 530. NANDI, H. K. (1946), "A further note on non-isomorphic solutions of incomplete block designs", *Sankhyā*, **7**, 313-6.
 531. RAO, C. R. (1946), "Confounded factorial designs in quasi-Latin squares", *Sankhyā*, **7**, 295-304.

532. RAO, C. R. (1947), "Factorial experiments derivable from combinatorial arrangements of arrays", *J. R. Statist. Soc. Suppl.*, 9, 128-39.
533. RAO, C. R. (1946), "Hypercubes of strength 'd' leading to confounded designs in factorial experiments", *Bull. Calcutta Math. Soc.*, 38, 67-78.
534. RIORDAN, J. (1944), "Three-line Latin rectangles", *Amer. Math. Mon.*, 51, 450-2.
535. RIORDAN, J. (1946), "Three-line Latin rectangles. II", *Amer. Math. Mon.*, 53, 18-20.
536. WILLIAMS, C. B. (1946), "Yule's 'Characteristic' and the 'index of diversity'", *Nature, Lond.*, 157, 482.

5. SAMPLING PROBLEMS AND TESTS OF PARTICULAR HYPOTHESES

5.11. Measures of Location

537. ANSCOMBE, F. J. (1946), "Linear sequential rectifying inspection for controlling fraction defective", *J. R. Statist. Soc. Suppl.*, 8, 216-22.
538. ANSCOMBE, F. J., GODWIN, H. J. & PLACKETT, R. L. (1947), "Methods of deferred sentencing in testing the fraction defective of a continuous output", *J. R. Statist. Soc. Suppl.*, 9, 198-217.
539. ARGANARAZ, C. J. M. (1947), "New methods in the calculation of a ballistic pattern", *An. Soc. Cient. Argent.*, 143, 49-82.
540. ARMITAGE, P. (1947), "Some sequential tests of Student's hypothesis", *J. R. Statist. Soc. Suppl.*, 9, 250-63.
541. BANCROFT, T. A. (1944), "On biases in estimation due to the use of preliminary tests of significance", *Ann. Math. Statist.*, 15, 190-204.
542. BARNARD, G. A. (1945), "A new test for 2×2 tables", *Nature*, 156, 177.
543. BARNARD, G. A. (1947), "Significance tests for 2×2 tables", *Biometrika*, 34, 123-38.
544. BARNARD, G. A. (1947), " 2×2 tables. A note on E. S. Pearson's paper", *Biometrika*, 34, 168-9.
545. BARTKY, W. (1943), "Multiple sampling with constant probability", *Ann. Math. Statist.*, 14, 363-77.
546. BARTLETT, M. S. (1946), "A modified probit technique for small probabilities", *J. R. Statist. Soc. Suppl.*, 8, 113-7.
547. BERKSON, J. (1946), "Approximation of chi-square by 'probits' and by 'logits'", *J. Amer. Statist. Ass.*, 41, 70-4.
548. BLACKWELL, D. & GIRSHICK, M. A. (1947), "A lower bound for the variance of some unbiased sequential estimates", *Ann. Math. Statist.*, 18, 277-80.
549. BLISS, C. I. & CATTELL, M. (1943), "Biological Assay", *Ann. Rev. Physiol.*, 5, 479-539.
550. COLE, L. C. (1945), "A simple test of the hypothesis that alternative events are equally probable", *Ecology*, 26, 202-5.
551. CURTISS, J. H. (1946), "A note on some single sampling plans requiring the inspection of a small number of items", *Ann. Math. Statist.*, 17, 62-70.
552. CURTISS, J. H. (1947), "Acceptance sampling by variables, with special reference to the case in which quality is measured by average or dispersion", *J. R. Nat. Bureau of Standards*, 39 (3), 271-90.
553. DALY, J. F. (1946), "On the use of the sample range in an analogue of Student's *t*-test", *Ann. Math. Statist.*, 17, 71-4.
554. DODGE, H. F. (1943), "A sampling inspection plan for continuous production", *Ann. Math. Statist.*, 14, 264-79.
555. EPSTEIN, B. & CHURCHMAN, C. W. (1944), "On the statistics of sensitivity data", *Ann. Math. Statist.*, 15, 90-6.
556. FESTINGER, L. (1946), "The significance of difference between means without reference to the frequency distribution function", *Psychometrika*, 11, 97-105.
557. FESTINGER, L. (1943), "An exact test of significance for means of samples drawn from populations with an exponential frequency distribution", *Psychometrika*, 8, 153-60.
558. FESTINGER, L. (1943), "A statistical test for means of samples from skew populations", *Psychometrika*, 8, 205-10.
559. FINNEY, D. J. (1947), "The principles of biological assay", *J. R. Statist. Soc. Suppl.*, 9, 46-91.
560. FINNEY, D. J. (1947), "The estimation from individual records of the relationship between dose and quantal response", *Biometrika*, 34, 320-34.
561. FINNEY, D. J. (1943), "The statistical treatment of toxicological data relating to more than one dosage factor", *Ann. Appl. Biol.*, 30, 71-9.
562. GHIZZETTI, A. (1945), "Sul problema del collaudo di partite di numerosi oggetti", *Consiglio Naz. Ricerche Pubbl. Ist.*, 164, 19 pp.
563. GHOSH, M. N., and ROY, S. N. (1947), "On a statistical test of treatment effect on certain diseases", *Sankhyā*, 8, 195-6.
564. GIRSHICK, M. A., MOSTELLER, F. & SAVAGE, L. J. (1946), "Unbiased estimates for certain binomial sampling problems with applications", *Ann. Math. Statist.*, 17, 13-23.
- 565A. HALDANE, J. B. S. (1945), "On a method of estimating frequencies", *Biometrika*, 33, 222-5.
- 565B. HOEL, P. G. (1945), "Testing the homogeneity of Poisson frequencies", *Ann. Math. Statist.*, 16, 362-8.
566. ITÔ, K. (1944), "On Student's test", *Proc. Imp. Acad. Japan*, 20, 694-700.
567. MOOD, A. M. (1943), "On the dependence of sampling inspection plans upon population distributions", *Ann. Math. Statist.*, 14, 415-25.
568. NOLFI, P. (1944), "Zur Bestimmung der Ruckschlusswahrscheinlichkeit einer geschlossenen Gesamtheit", *Mitt. Ver. Schweiz. Versich.-Math.*, 44, 217-20.

1951]

569. PEARSON, E. S. (1947), "The choice of statistical tests illustrated on the interpretation of data classed in a 2×2 table", *Biometrika*, **34**, 139-67.
570. PILLAI, K. S. (1943), "A note on Poisson distribution", *Proc. Ind. Acad. Sci., Sect. A*, **18**, 179-89.
571. ROSENBLATT, A. (1944), "On the application of mathematical statistics to bacteriology. I. Method of dilution of Louis Pasteur. Case of a single dilution. Application of the second law of P. S. Laplace", *Univ. Nac. Tucumán. Rev. A*, **4**, 217-34.
572. SAVAGE, L. J. (1947), "A uniqueness theorem for unbiased sequential binomial estimation", *Ann. Math. Statist.*, **18**, 295-7.
573. SCHEFFÉ, H. (1943), "On solutions of the Behrens-Fisher problem, based on the t -distribution", *Ann. Math. Statist.*, **14**, 35-44.
574. SCHEFFÉ, H. (1944), "A note on the Behrens-Fisher problem", *Ann. Math. Statist.*, **15**, 430-2.
575. SCHEFFÉ, H. (1944), "Note on the use of the tables of percentage points of the incomplete beta function to calculate small sample confidence intervals for a binomial p ", *Biometrika*, **33**, 181.
576. SIMON, H. A. (1943), "Symmetric tests of the hypothesis that the mean of one normal population exceeds that of another", *Ann. Math. Statist.*, **14**, 149-54.
577. SMITH, J. H. (1947), "Estimation of linear functions of cell proportions", *Ann. Math. Statistics*, **18**, 231-54.
578. STEIN, C. (1945), "A two-sample test for a linear hypothesis whose power is independent of the variance", *Ann. Math. Statist.*, **16**, 243-58.
579. STEIN, C. & WALD, A. (1947), "Sequential confidence intervals for the mean of a normal distribution with known variance", *Ann. Math. Statist.*, **18**, 427-33.
580. SWAN, A. W. (1945), "Sampling schemes for qualitative inspection", *Inst. Mech. Engrs. J. Proc.*, **152**, 81-92.
581. WALD, A. & WOLFOWITZ, J. (1945), "Sampling inspection plans for continuous production which insure a prescribed limit on the outgoing quality", *Ann. Math. Statist.*, **16**, 30-49.
582. WALD, A. (1945), "Sequential method of sampling for deciding between two courses of action", *J. Amer. Statist. Ass.*, **40**, 277-306.
583. WALSH, J. E. (1946), "Some significance tests based on order statistics", *Ann. Math. Statist.*, **17**, 44-52.
584. WALSH, J. E. (1946), "On the power function of the sign test for slippage of means", *Ann. Math. Statist.*, **17**, 358-62.
585. WISE, M. E. (1946), "The use of the negative binomial distribution in an industrial sampling problem", *J. R. Statist. Soc. Suppl.*, **8**, 202-11.
586. WOLFOWITZ, J. (1946), "On sequential binomial estimation", *Ann. Math. Statist.*, **17**, 489-93.
587. WOLFOWITZ, J. (1947), "Consistency of sequential binomial estimates", *Ann. Math. Statist.*, **18**, 131-5.

5.111. *Linear Hypotheses including Analysis of Variance, Regression, etc.*

588. ARMITAGE, P. (1947), "A comparison of stratified with unrestricted random sampling from a finite population", *Biometrika*, **34**, 273-80.
589. AROIAN, L. A. (1944), "Some methods for the evaluation of a sum", *J. Amer. Statist. Ass.*, **39**, 511-5.
590. AYYANGER, A. A. K. (1945), "Interaction formulae in analysis of variance", *Curr. Sci.*, **14**, 35.
591. BATEN, W. D. (1945), "Analysing degrees of freedom into comparisons when the 'classes' do not contain the same number of items", *Nat. Math. Mag.*, **19**, 221-8.
592. BIRGE, R. T. (1947), "Least squares fitting of data by means of polynomials", *Rev. Mod. Phys.*, **19**, 298-360.
593. BLISS, C. I. (1946), "An experimental design for slope-ratio assays", *Ann. Math. Statist.*, **17**, 232-7.
594. CHRZASZCZ, R. (1943), "Ein Problem der Bestimmung und Eliminierung von systematischen Beobachtungsfehlern", *Sammlung wissen. Arb. Schweiz. int. Pol.*, Band 1, Heft 3, 23-26. Eidg. Kommissariat für Internierung und Hospitalisierung.
595. COCHRAN, W. G. (1947), "Some consequences when the assumptions for the analysis of variance are not satisfied", *Biometrika*, **3**, 22-38.
596. COCHRAN, W. G. (1943), "Analysis of variance for percentages based on unequal numbers", *J. Amer. Statist. Ass.*, **38**, 287-301.
597. COLLATZ, L. & ZURMÜHL, R. (1944), "Glatten und Vertafeln empirischer Funktionen mittels Differenzen", *Z. Ver. Dtsch. Ing.*, **88**, 511-5.
598. CORNISH, E. A. (1943), "The recovery of inter-block information in quasi-factorial designs with incomplete data. I. Square, triple, and cubic lattices", *Comm. Aust. Counc. Sci. Ind. Res. Bull.*, **158**.
599. CORNISH, E. A. (1944), "The recovery of inter-block information in quasi-factorial designs with incomplete data. II. Lattice squares", *Comm. Aust. Counc. Sci. Ind. Res. Bull.*, **175**.
600. DE LURY, D. B. (1946), "The analysis of Latin squares when some observations are missing", *J. Amer. Statist. Ass.*, **41**, 370-89.
601. EISENHART, C. (1947), "The assumptions underlying the analysis of variance", *Biometrika*, **3**, 1-21.
602. GONIN, H. T. (1944), "Curve fitting by means of the orthogonal polynomials in binomial statistical distributions", *Trans. Roy. Soc. S. Afr.*, **30**, 207-15.
603. HANSEN, M. H. & HURWITZ, W. N. (1943), "On the theory of sampling from finite populations", *Ann. Math. Statist.*, **14**, 333-62.
604. HANSEN, M. H., HURWITZ, W. N. & GURNEY, M. (1946), "Problems and methods of the sample survey of business", *J. Amer. Statist. Ass.*, **41**, 173-89.

605. HANSEN, M. H. & HURWITZ, W. N. (1946), "The problem of non-response in sample surveys", *J. Amer. Statist. Ass.*, **41**, 517-29.
606. HARSHBARGER, B. (1945), "On the analysis of a certain six-by-six four-group lattice design using the recovery of interblock information", *Ann. Math. Statist.*, **16**, 387-90.
607. HARSHBARGER, B. (1944), "On the analysis of a certain six-by-six four-group lattice design", *Ann. Math. Statist.*, **15**, 307-20.
608. HOTELLING, H. (1944), "Some improvements in weighing and other experimental techniques", *Ann. Math. Statist.*, **15**, 297-306.
609. HSU, P. L. (1943), "Some simple facts about the separation of degrees of freedom in factorial experiments", *Sankhyā*, **6**, 253-4.
610. HUSSAIN, Q. M. (1943), "A note on interaction", *Sankhyā*, **6**, 321-2.
611. JONES, H. L. (1946), "Linear regression functions with neglected variables", *J. Amer. Statist. Ass.*, **41**, 356-69.
612. KISHEN, K. (1945), "On the design of experiments for weighing and making other types of measurements", *Ann. Math. Statist.*, **16**, 294-300.
613. KOLMOGOROV, A. N. (1946), "On the proof of the method of least squares", *Usp. Mat. Nauk.*, **1**, 57-70.
614. MADOW, W. G. & MADOW, L. H. (1944), "On the theory of systematic sampling. I", *Ann. Math. Statist.*, **15**, 1-24.
615. MADOW, L. H. (1946), "Systematic sampling and its relation to other sampling designs", *J. Amer. Statist. Ass.*, **41**, 204-17.
616. MAHALANOBIS, P. C. (1944), "On large-scale sample surveys", *Phil. Trans. Roy. Soc. Lond.*, **B**, **231**, 329.
617. MARCANTONI, A. (1946), "Saggio di un'applicazione del calcolo delle matrici alla teoria degli errori", *Univ. Roma Ist. Naz. Alta Mat. Rend. Mat. e Appl.*, **5**, 252-70.
618. MOOD, A. M. (1946), "On Hotelling's weighing problem", *Ann. Math. Statist.*, **17**, 432-46.
619. NAIR, K. R. (1944), "The recovery of inter-block information in incomplete block designs", *Sankhyā*, **6**, 383-90.
620. PHIPPS, I. F., PUGSLEY, A. T., HOCKLEY, S. R. & CORNISH, E. A. (1944), "The analysis of cubic lattice designs in varietal trials", *Comm. Aust. Council Sci. Ind. Res. Bull.*, **176**.
621. PINNEY, E. (1947), "Fitting curves with zero or infinite end points", *Ann. Math. Statist.*, **18**, 127-31.
622. PLACKETT, R. L. (1946), "Some generalizations in the multifactorial design", *Biometrika*, **33**, 328-32.
623. PLACKETT, R. L. & BURMAN, J. P. (1946), "The design of optimum multifactorial experiments", *Biometrika*, **33**, 305-25.
624. RAO, C. R. (1945), "Generalization of Markoff's theorem and tests of linear hypotheses", *Sankhyā*, **7**, 9-16.
625. RAO, C. R. (1945), "Markoff's theorem with linear restrictions on parameters", *Sankhyā*, **7**, 16-9.
626. RAO, C. R. (1944), "On the linear set up leading to intra and inter block informations", *Science and Culture*, **10**, 259-60.
627. RAO, C. R. (1946), "On the most efficient designs in weighing", *Sankhyā*, **7**, 440.
628. RAO, C. R. (1946), "On the linear combination of observations and the general theory of least squares", *Sankhyā*, **7**, 237-56.
629. SMITH, M. F. (1947), "Standard errors of means in sampling surveys with two-stage sampling", *J. R. Statist. Soc.*, **110**, 257-9.
630. TSAO, F. (1946), "General solution of the analysis of variance and covariance in the case of unequal or disproportionate numbers of observations in the subclasses", *Psychometrika*, **11**, 107-28.
631. VAJDA, S. (1945), "On the constituent items of the reduction and the remainder in the method of least squares", *Ann. Math. Statist.*, **16**, 381-6.
632. VERNOTTE, P. (1943), "Représentation d'une courbe expérimentale, dans un cas général, par la condition de moindre imprécision", *C. R. Acad. Sci. Paris*, **216**, 148-50.
633. VERNOTTE, P. (1943), "Détermination, par la méthode de moindre imprécision, des coefficients d'une formule représentant une courbe expérimentale, ou ils figurent linéairement", *C. R. Acad. Sci. Paris*, **215**, 568-70.
634. VERNOTTE, P. (1943), "Détermination, par la condition de moindre imprécision d'une formule dépendant linéairement de paramètres, destinée à la représentation d'une courbe expérimentale", *C. R. Acad. Sci. Paris*, **216**, 33-5.
635. VERNOTTE, P. (1943), "Sur les systèmes d'équations auxquels conduit la méthode de la moindre imprécision", *C. R. Acad. Sci. Paris*, **216**, 289-91.
636. VERNOTTE, P. (1945), "Détermination, par la condition de moindre imprécision, du polynôme du second degré représentant au mieux l'ensemble d'une courbe expérimentale", *C. R. Acad. Sci. Paris*, **221**, 609-11.
637. VILLARS, D. S. (1947), "A significance test and estimation in the case of exponential regression", *Ann. Math. Statist.*, **18**, 596-600.
638. WALD, A. (1944), "Note on a lemma", *Ann. Math. Statist.*, **15**, 330-3.
639. WALD, A. (1943), "On the efficient design of statistical investigations", *Ann. Math. Statist.*, **14**, 134-40.
640. WALSH, J. E. (1947), "An extension to two populations of an analogue of Student's *t*-test using the sample range", *Ann. Math. Statist.*, **18**, 280-5.
641. WALSH, J. E. (1947), "On the power efficiency of a *t*-test formed by pairing sample values", *Ann. Math. Statist.*, **18**, 601-4.
642. YATES, F. (1946), "A review of recent statistical developments in sampling and sampling surveys", *J. R. Statist. Soc.*, **109**, 12-30.

1951]

5.12. Measures of Spread, Spread and Location

643. BOWKER, A. H. (1946), "Computation of factors for tolerance limits on a normal distribution when the sample is large", *Ann. Math. Statist.*, 17, 238-40.
644. CARLTON, A. (1946), "Estimating the parameters of a rectangular distribution", *Ann. Math. Statist.*, 17, 355-8.
645. GUTTMAN, L. (1946), "The test-retest reliability of qualitative data", *Psychometrika*, 11, 81-95.
646. MORSE, A. P., & GRUBBS, F. E. (1947), "The estimation of dispersion from differences", *Ann. Math. Statist.*, 18, 194-214.
647. MOSTELLER, F. (1946), "On some useful 'inefficient' statistics", *Ann. Math. Statist.*, 17, 377-408.
648. SCHEFFÉ, H. & TUKEY, J. W. (1944), "A formula for sample sizes for population tolerance limits", *Ann. Math. Statist.*, 15, 217.
649. TUKEY, J. W. (1947), "Non-parametric estimation. II. Statistically equivalent blocks and tolerance regions—The continuous case", *Ann. Math. Statist.*, 18, 529-39.
650. WALD, A. & WOLFOWITZ, J. (1946), "Tolerance limits for a normal distribution", *Ann. Math. Statist.*, 17, 208-15.
651. WOLFOWITZ, J. (1946), "Confidence limits for the fraction of a normal population which lies between two given limits", *Ann. Math. Statist.*, 17, 483-8.

5.13. Measures of Shape and Comparison of Frequency Curves

652. BAPTIST, J. H. (1945), "Étude de la dépendance stochastique", *Assoc. Actu. Belges. Bull.*, 50, 15-36.
653. BOWKER, A. H. (1944), "Note on consistency of a proposed test for the problem of two samples", *Ann. Math. Statist.*, 15, 98-101.
654. GEARY, R. C. (1947), "Testing for normality", *Biometrika*, 34, 208-42.
655. HALD, A. H. (1946), "The truncated normal distribution", *Mat. Tidsskr. B.*, 1946, 83-91.
656. HOEL, P. G. (1947), "Discriminating between binomial distributions", *Ann. Math. Statist.*, 18, 556-64.
657. KIMBALL, B. F. (1947), "Some basic theorems for developing tests of fit for the case of the non-parametric probability distribution function. I", *Ann. Math. Statist.*, 18, 540-8.
658. MANN, H. B. (1945), "Nonparametric tests against trend", *Econometrika*, 13, 245-59.
659. MANN, H. B. & WHITNEY, D. R. (1947), "On a test of whether one of two random variables is stochastically larger than the other", *Ann. Math. Statist.*, 18, 50-60.
660. MATHEN, K. K. (1946), "A criterion for testing whether two samples have come from the same population without assuming the nature of the population", *Sankhyā*, 7, 329.
661. MATHISEN, H. C. (1943), "A method of testing the hypothesis that two samples are from the same population", *Ann. Math. Statist.*, 14, 188-94.
662. MISES, R. VON (1945), "On the classification of observation data into distinct groups", *Ann. Math. Statist.*, 16, 68-73.
663. PIERCE, J. A. (1943), "Correction formulas for moments of a grouped-distribution of discrete variates", *J. Amer. Statist. Ass.*, 38, 57-62.
664. QUENSEL, C.-E. (1945), "Studies of the logarithmic normal curve", *Skand. Aktuar. Tidskr.*, 28, 141-53.
665. SCHÄRF, H. (1944), "Über partielle Bestandsänderungen und eine Klasse Neuer Integrationsprozesse", *Mitt. Ver. Schweiz. Versich.-Math.*, 44, 233-49.
666. SCHILLING, W. (1947), "A frequency distribution represented as the sum of two Poisson distributions", *J. Amer. Statist. Ass.*, 42, 407-24.
667. SMIRNOV, N. V. (1947), "Sur un critère de symétrie de la loi de distribution d'une variable aléatoire", *C. R. Acad. Sci. U.R.S.S. Doklady*, 56, 11-4.

5.14. Tests for Randomness

668. DAVID, F. N. (1947), "A power function for tests of randomness in a sequence of alternatives", *Biometrika*, 34, 335-9.
669. DIXON, W. J. (1944), "Further contributions to the problem of serial correlation", *Ann. Math. Statist.*, 15, 119-44.
670. MANN, H. B. (1945), "On a test for randomness based on signs of differences", *Ann. Math. Statist.*, 16, 193-9.
671. WALD, A. & WOLFOWITZ, J. (1943), "An exact test for randomness in the non-parametric case based on serial correlation", *Ann. Math. Statist.*, 14, 378-88.
672. VILLE, J. (1943), "Sur l'application, à un critère d'indépendance, du dénombrement des inversions présentées par une permutation", *C. R. Acad. Sci. Paris*, 217, 41-2.
673. WOLFOWITZ, J. (1943), "On the theory of runs with some applications to equality control", *Ann. Math. Statist.*, 14, 280-8.

5.15. Miscellaneous

674. GAGE, R. (1943), "Contents of Tippet's 'Random Sampling Numbers'", *J. Amer. Statist. Ass.*, 38, 223-7.

5.2. Bivariate

675. AUSTEN, A. E. W. & PELZER, H. (1946), "Linear 'curves of best fit'", *Nature*, 157, 693-4.
676. BOSE, C. (1943), "Note on the sampling error in the method of double sampling", *Sankhyā*, 6, 329-30.

677. COCHRAN, W. G. (1943), "The comparison of different scales of measurement for experimental results", *Ann. Math. Statist.*, **14**, 205-16.
678. FIELLER, E. C. (1944), "A fundamental formula in the statistics of biological assay, and some applications", *Quart. J. Pharm.*, **17**, 117-23.
679. GEPPERT, M-P. (1944), "Über den Vergleich zweier beobachteter Häufigkeiten", *Dtsche. Math.*, **7**, 553-92.
680. LEVENE, H. (1946), "A test of randomness in two dimensions", *Bull. Amer. Math. Soc.*, **52**, 621.
681. LINDLEY, D. V. (1947), "Regression lines and the linear functional relationship", *J. R. Statist. Soc. Suppl.*, **9**, 218-44.
682. MOSTELLER, F. (1946), "On some useful 'inefficient' statistics", *Ann. Math. Statist.*, **17**, 377-408.
683. NAIR, K. R. & BANERJEE, K. S. (1943), "A note on fitting of straight lines if both variables are subject to error", *Sankhyā*, **6**, 331.
684. NANDI, H. K. (1947), "A note on Student's *t* for paired samples", *Bull. Calcutta Math. Soc.*, **39**, 61-4.
685. OLMSTEAD, P. S. & TUKEY, J. W. (1947), "A corner test for association", *Ann. Math. Statist.*, **18**, 495-513.
686. PAULSON, E. (1943), "A note on tolerance limits", *Ann. Math. Statist.*, **14**, 90-3.
687. SEARES, F. H. (1944), "Regression lines and the functional relation", *Astrophys. J.*, **100**, 155-63.
688. VILLARS, D. S. & ANDERSON, T. W. (1943), "Some significance tests for normal bivariate distributions", *Ann. Math. Statist.*, **14**, 141-8.

5.3. Multivariate

689. BARTLETT, M. S. (1947), "Multivariate analysis", *J. R. Statist. Soc. Suppl.*, **9**, 176-90; discussion, 190-7.
690. BHARGAVA, R. P. (1946), "Test of significance for intra class correlation when family sizes are not equal", *Sankhyā*, **7**, 435-8.
691. BROWN, G. W. (1947), "Discriminant functions", *Ann. Math. Statist.*, **18**, 514-28.
692. DELAPORTE, P. (1946), "Sur l'estimation des corrélations des caractères avec le facteur général et les facteurs de groupe et sur l'écart-type de cette estimation, en analyse factorielle", *C. R. Acad. Sci. Paris*, **222**, 525-7.
693. GEARY, R. C. (1944), "Relations between statistics: the general and the sampling problem when the samples are large", *Proc. R. Irish Acad. Sect. A*, **49**, 177-96.
694. GUTTMAN, L. & COHEN, J. (1943), "Multiple rectilinear prediction and the resolution into compartments. II", *Psychometrika*, **8**, 169-83.
695. HERDAN, G. (1943), "The logical and analytical relationship between the theory of accidents and factor analysis", *J. R. Statist. Soc.*, **106**, 125-42.
696. HOLZINGER, K. J. (1946), "A comparison of the principle-axis and centroid factors", *J. Educ. Psychol.*, **37**, 409-72.
697. HOLZINGER, K. J. (1944), "A simple method of factor analysis", *Psychometrika*, **9**, 257-61.
698. HOLZINGER, K. J. (1944), "Factoring test scores and implications for the method of averages", *Psychometrika*, **9**, 155-67.
699. HSU, P. L. (1945), "On the power functions of the E^2 -test and the T^2 -test", *Ann. Math. Statist.*, **16**, 278-86.
700. LAWLEY, D. N. (1944), "The factorial analysis of multiple item tests", *Proc. Roy. Soc. Edin. Sect. A*, **62**, 74-82.
701. LAWLEY, D. N. (1943), "On problems connected with item selection and test construction", *Proc. Roy. Soc. Edin. Sect. A*, **61**, 273-87.
702. NANDI, H. K. (1947), "A mathematical set-up leading to analysis of a class of designs", *Sankhyā*, **8**, 172-6.
703. NANDI, H. K. (1946), "On the power function of Studentised D^2 -statistic", *Bull. Calcutta Math. Soc.*, **38**, 79-84.
704. PENROSE, L. S. (1947), "Some notes on discrimination", *Ann. Eugen. Lond.*, **13**, 228-37.
705. PLACKETT, R. L. (1947), "An exact test for the equality of variances", *Biometrika*, **34**, 311-9.
706. RAO, C. R. (1946), "Tests with discriminant functions in multivariate analysis", *Sankhyā*, **7**, 407-14.
707. REIERSÖL, O. (1945), "Confluence analysis by means of instrumental sets of variables", *Ark. Mat. Astr. Fys.*, **32A**, (4), 119.
708. RUIST, E. (1946), "Standard errors of the tilling coefficients used in confluence analysis", *Econometrica*, **14**, 235-41.
709. SLATER, P. (1947), "The factor analysis of a matrix of 2×2 tables", *J. R. Statist. Soc. Suppl.*, **9**, 114-27.
710. SMITH, C. A. B. (1947), "Some examples of discrimination", *Ann. Eugen.*, **13**, 272-82.
711. THURSTONE, L. L. (1945), "A multiple group method of factoring the correlation matrix", *Psychometrika*, **10**, 73-8.
712. THURSTONE, L. L. (1944), "Graphical method of factoring the correlation matrix", *Proc. Nat. Acad. Sci. Wash.*, **30**, 129-34.
713. TINTNER, G. (1944), "An application of the variate difference method to multiple regression", *Econometrica*, **12**, 97-113.
714. TINTNER, G. (1945), "A note on rank, multicollinearity and multiple regression", *Ann. Math. Statist.*, **16**, 304-8.
715. TINTNER, G. (1946), "Multiple regression for systems of equations", *Econometrica*, **14**, 5-36.

1951]

716. WALD, A. (1947), "A note on regression analysis", *Ann. Math. Statist.*, **18**, 586-9.
 717. WALD, A. (1943), "An extension of Wilks' method for setting tolerance limits", *Ann. Math. Statist.*, **14**, 45-55.
 718. WALD, A. (1944), "On a statistical problem arising in the classification of an individual into one of two groups", *Ann. Math. Statist.*, **15**, 145-62.
 719. WHERRY, R. J. (1947), "Multiple bi-serial and multiple point bi-serial correlation", *Psychometrika*, **12**, 189-95.
 720. WILKS, S. S. (1946), "Sample criteria for testing equality of means, equality of variances, and equality of covariances in normal multivariate distribution", *Ann. Math. Statist.*, **17**, 257-81.

6. STOCHASTIC PROCESSES

721. ALBERT, G. E. (1947), "A note on the fundamental identity of sequential analysis", *Ann. Math. Statist.*, **18**, 593-6.
 722. ARLEY, N. (1944), "On the elementary, time-homogeneous, discontinuous, stochastically definite process", *Skand. Aktuar. Tidskr.*, **27**, 172-6.
 723. BARKALAIA, A. (1944), "Sur des chaînes de Markoff", *Uchen. Zapisk. Moskov. Gos. Univ. Mat.*, **73**, 33-6.
 724. BARTETT, M. S. (1946), "The large-sample theory of sequential tests", *Proc. Camb. Phil. Soc.*, **42**, 239-44.
 725. BASS, J. (1945), "Sur la structure des fonctions aléatoires", *C. R. Acad. Sci. Paris*, **220**, 190-2.
 726. BASS, J. (1947), "Sur le corpuscule aléatoire à masse aléatoire", *C. R. Acad. Sci. Paris*, **225**, 38-40.
 727. BASS, J. (1945), "Quelques conséquences mécaniques de l'équation de structure d'un corpuscule aléatoire", *C. R. Acad. Sci. Paris*, **220**, 272-4.
 728. BASS, J., DEDEBANT, G. & WEHRLE, P. (1945), "Les équations différentielles aléatoires", *C. R. Acad. Sci. Paris*, **221**, 168-71.
 729. BERG, W. F. (1945), "Aggregates in one- and two-dimensional random distributions. (Developability of silver specks of known dimensions and the size of photographic sensitivity specks)", *Phil. Mag.*, **36**, 337-46.
 730. BLACKWELL, D. (1945), "Finite non-homogeneous chains", *Ann. Math.*, **46**, 594-9.
 731. BLACKWELL, D. (1945), "The existence of anormal chains", *Bull. Amer. Math. Soc.*, **51**, 465-8.
 732. BLACKWELL, D. (1946), "On an equation of Wald", *Ann. Math. Statist.*, **17**, 84-7.
 733. BLANC-LAPIERRE, A. (1943), "Sur les fluctuations produites par l'effet de grenaille dans les amplificateurs", *C. R. Acad. Sci. Paris*, **217**, 73-4.
 734. BLANC-LAPIERRE, A. (1945), "Sur l'effet de scintillation", *C. R. Acad. Sci. Paris*, **221**, 375-7.
 735. BLANC-LAPIERRE, A. (1946), "Étude des fluctuations produites par l'effet de grenaille dans les amplificateurs", *Rev. Sci.*, **84**, 75-94.
 736. BLANC-LAPIERRE, A. (1945), "Effet Schottky, Fluctuations dans les amplificateurs linéaires et dans les détecteurs", *Bull. Soc. Française Electriciens*, **5**, 9.
 737. BLANC-LAPIERRE, A. (1944), "Sur quelques propriétés ergodiques de certaines fonctions aléatoires", *C. R. Acad. Sci. Paris*, **218**, 985-6.
 738. BLANC-LAPIERRE, A. (1947), "Remarques sur l'analyse harmonique des fonctions aléatoires", *Rev. Sci.*, **85**, 1027-40.
 739. BLANC-LAPIERRE, A. (1944), "Sur certaines fonctions aléatoires introduites par un problème d'électricité", *C. R. Acad. Sci. Paris*, **218**, 924-5.
 740. BLANC-LAPIERRE, A. (1945), "Les fonctions aléatoires stationnaires laplaciennes", *C. R. Acad. Sci. Paris*, **220**, 378-80.
 741. BLANC-LAPIERRE, A. (1947), "Sur quelques problèmes posés par la détermination des spectres de puissance ou d'énergie des grandeurs aléatoires", *C. R. Acad. Sci. Paris*, **225**, 1264-6.
 742. BLANC-LAPIERRE, A. (1947), "Remarques sur les propriétés énergétiques des fonctions aléatoires", *C. R. Acad. Sci. Paris*, **225**, 982-4.
 743. BLANC-LAPIERRE, A. & BRARD, R. (1945), "La loi forte des grands nombres pour les fonctions aléatoires stationnaires continues", *C. R. Acad. Sci. Paris*, **220**, 134-6.
 744. BLANC-LAPIERRE, A. & BRARD, R. (1946), "Les fonctions aléatoires stationnaires et la loi des grands nombres", *Bull. Soc. Math. Fr.*, **74**, 102-15.
 745. BLANC-LAPIERRE, A. & FORTET, R. (1946), "Extension de la méthode des filtres à des fonctions aléatoires non stationnaires", *C. R. Acad. Sci. Paris*, **222**, 1270-1.
 746. BLANC-LAPIERRE, A. & FORTET, R. (1947), "Les fonctions aléatoires stationnaires de plusieurs variables", *Rev. Sci.*, **85**, 419-22.
 747. BLANC-LAPIERRE, A. & FORTET, R. (1946), "Sur la décomposition spectrale des fonctions aléatoires stationnaires d'ordre deux", *C. R. Acad. Sci. Paris*, **222**, 467-8.
 748. BLANC-LAPIERRE, A. & FORTET, R. (1946), "Résultats sur la décomposition spectrale des fonctions aléatoires stationnaires d'ordre deux", *C. R. Acad. Sci. Paris*, **222**, 713-4.
 749. BLANC-LAPIERRE, A. & FORTET, R. (1947), "Sur une propriété fondamentale des fonctions de corrélation", *C. R. Acad. Sci. Paris*, **224**, 786-8.
 750. BLANC-LAPIERRE, A. & FORTET, R. (1946), "Sur la structure des fonctions aléatoires strictement stationnaires à spectre totalement discontinu", *C. R. Acad. Sci. Paris*, **222**, 1155-7.
 751. BLANC-LAPIERRE, A. & FORTET, R. (1947), "Analyse harmonique des fonctions aléatoires et caractère stationnaire", *C. R. Acad. Sci. Paris*, **225**, 1119-20.
 752. BLANC-LAPIERRE, A. & LAPOSTOLLE, P. (1946), "Fluctuations dans les grandeurs physiques quasi sinusoïdales", *C. R. Acad. Sci. Paris*, **222**, 1324-5.

753. BLANC-LAPIERRE, A. et LAPOSTOLLE, P. (1946), "Fluctuations dans les grandeurs physiques quasi sinusoidales", *J. Phys. Radium*, 7, 153-64.
754. BOGOLYUBOV, N. N. (1945), "On the influence of a random force on a harmonic oscillator", *Uchen. Zap. Moskov. Gos. Univ. Fiz.*, 77, 51-73.
755. BOONIMOVICH, V. (1946), "Effect of the fluctuations and signal voltages on a non-linear system", *C. R. Acad. Sci. U.R.S.S. J. Phys.*, 10, 35-48.
756. BUNIMOVICH, V. I. & LEONTOVICH, M. A. (1946), "On the distribution of the number of large deviations in electric fluctuations", *C. R. Acad. Sci. U.R.S.S. (Doklady)*, 53, 21-3.
757. BURMAN, J. P. (1946), "Sequential sampling formulae for a binomial population", *J. R. Statist. Soc. Suppl.*, 8, 98-103.
758. BURNENS, E. (1947), "Die Erfahrungsnachwirkung bei Wahrscheinlichkeiten", *Mitt. Verein. Schweiz. Versich. Math.*, 47, 329-52.
759. CAMPBELL, N. R. & FRANCIS, V. J. (1946), "Random fluctuations in a cathode ray oscillograph", *Phil. Mag.*, (7) 37, 289-310.
760. CERNUSCHI, F. & SALEME, E. (1944), "A new scheme of contagion in probability", *Ann. Soc. Ci. Argentina*, 138, 201-13.
761. CHANDRASEKHAR, S. (1943), "Stochastic problems in physics and astronomy", *Rev. Mod. Phys.*, 15, 1-89.
762. COULSON, C. A. (1947), "Note on the random-walk problem," *Proc. Camb. Phil. Soc.*, 43, 583-6.
763. CUNNINGHAM, L. B. C. & HYND, W. R. B. (1946), "Random processes in problems of air warfare", *J. R. Statist. Soc. Suppl.*, 8, 62-85.
764. DANIELS, H. E. (1947), "Grouping corrections for high autocorrelations", *J. R. Statist. Soc., Suppl.*, 9, 245-9.
765. DOOB, J. L. (1945), "Markoff chains—denumerable case", *Trans. Amer. Math. Soc.*, 58, 455-73.
766. DOOB, J. L. (1944), "The elementary Gaussian processes", *Ann. Math. Statist.*, 15, 229-82.
767. DRESSEL, P. L. (1940), "Statistical semivariants and their estimates with particular emphasis on their relation to algebraic invariants", *Ann. Math. Statist.*, 11, 33-57.
768. DUBOURDIEU, J. (1947), "Sur une généralisation d'un théorème de M.B. de Finetti et son application à la théorie collective du risque", *C. R. Acad. Sci. Paris*, 224, 514-6.
769. DUBROVSKY, V. (1944), "Investigation of purely discontinuous random processes by means of integro-differential equations", *Bull. Acad. Sci. U.R.S.S. Ser. Math. Izvestia Akad.*, 8, 107-28.
770. DUBROVSKY, V. M. (1945), "On purely discontinuous random processes with residual effect", *C. R. Acad. Sci. U.R.S.S. Doklady*, 47, 79-81.
771. DUBROVSKY, V. M. (1945), "On a problem connected with purely discontinuous random processes", *C. R. Acad. Sci. U.R.S.S. Doklady*, 47, 459-61.
772. ELFVING, G. (1946), "Contributions to the theory of integer-valued Markoff processes", *Skand. Aktuar. Tidskr.*, 29, 175-205.
773. ELFVING, G. (1946), "On a class of elementary Markoff processes", *C. R. Dixième Congr. Math. Scand.*, 149-59.
774. ELFVING, G. (1946), "On compound binomial processes", *Förs. Mat. Stud. Lundberg*, 48-78. Stockholm.
775. FAN, K. (1945), "Généralisations du théorème de M. Khintchine sur la validité de la loi des grands nombres pour les suites stationnaires de variables aléatoires", *C. R. Acad. Sci. Paris*, 220, 102-4.
776. FAN, K. (1944), "Sur l'approximation et l'intégration des fonctions aléatoires", *Bull. Soc. Math. Fr.*, 72, 97-117.
777. FAN, K. (1944), "Une définition descriptive de l'intégrale stochastique", *C. R. Acad. Sci. Paris*, 218, 953-5.
778. FELLER, W. (1945), "Note on the law of large numbers and 'fair' games", *Ann. Math. Statist.*, 16, 301-4.
779. FINSLER, P. (1945), "Über die Wahrscheinlichkeit seltener Erscheinungen", *Experientia*, 1, 56-7.
780. FORTET, R. (1943), "Les fonctions aléatoires du type de Markoff associées à certaines équations linéaires aux dérivées partielles du type parabolique", *J. Math. Pures Appl.*, 22, 177-243.
781. FRANCKX, E. (1945), "L'évolution des collectivités", *Mitt. Verein. Schweiz. Versich.-Math.*, 45, 279-88.
782. GIHMAN, I. I. (1947), "On a scheme of formation of random processes", *C. R. Acad. Sci. U.R.S.S. Doklady*, 58, 961-4.
783. GNEDENKO, B. (1943), "Sur la croissance des processus stochastiques homogènes à accroissements indépendants", *Bull. Acad. Sci. U.R.S.S. Ser. Math. Izvestia Akad.*, 7, 89-110.
784. GNEDENKO, B. V. (1943), "On the iterated logarithm law for homogeneous random processes with independent increments", *C. R. Acad. Sci. U.R.S.S. Doklady*, 40, 255-6.
785. GNEDENKO, B. V. (1943), "On the growth of homogeneous random processes with independent single-type increments", *C. R. Acad. Sci. U.R.S.S. Doklady*, 40, 90-3.
786. HADWIGER, H. (1945), "Die Erfahrungsnachwirkung bei Wahrscheinlichkeiten", *Experientia*, 1, 87-9.
787. HALMOS, P. R. (1944), "Random alms", *Ann. Math. Statist.*, 15, 182-9.
788. HARRIS, T. E. (1947), "Note on differentiation under the expectation sign in the fundamental identity of sequential analysis", *Ann. Math. Statist.*, 18, 294-5.
789. HURWITZ, H., Jr. & KAC, M. (1944), "Statistical analysis of certain types of random functions", *Ann. Math. Statist.*, 15, 173-81.
790. ITÔ, K. (1944), "On the ergodicity of a certain stationary process", *Proc. Imp. Acad. Japan*, 20, 54-5.
791. ITÔ, K. (1944), "On the normal stationary process with no hysteresis", *Proc. Imp. Acad. Japan*, 20, 199-202.

1951]

792. ITO, K. (1944), "Stochastic integral", *Proc. Imp. Acad. Japan*, **20**, 519-24.
793. KAC, M. (1945), "Random walk in the presence of absorbing barriers", *Ann. Math. Statist.*, **16**, 62-7.
794. KAC, M. (1947), "On the notion of recurrence in discrete stochastic processes", *Bull. Amer. Math. Soc.*, **53**, 1002-10.
795. KAC, M. (1946), "On the average of a certain Wiener functional and a related limit theorem in calculus of probability", *Trans. Amer. Math. Soc.*, **59**, 401-14.
796. KAC, M. & SIEGERT, A. J. F. (1947), "On the theory of noise in radio receivers with square law detectors", *J. Appl. Phys.*, **18**, 383-97.
797. KAC, M. & SIEGERT, A. J. F. (1947), "An explicit representation of a stationary Gaussian process", *Ann. Math. Statist.*, **18**, 438-42.
798. KAKUTANI, S. (1944), "Two dimensional Brownian motion and harmonic functions", *Proc. Imp. Acad. Japan*, **20**, 706-14.
799. KAKUTANI, S. (1944), "On Brownian motions in n -space", *Proc. Imp. Acad. Japan*, **20**, 648-52.
800. KAMPE DE FERIET, J. (1947), "Analyse harmonique des fonctions aléatoires strictement stationnaires", *C. R. Acad. Sci. Paris*, **225**, 623-4.
801. KARHUNEN, K. (1946), "Zur Spektraltheorie stochastischer Prozesse", *Ann. Acad. Sci. Fenn. Ser. A. I. Math. Phys.*, **34**, 7 pp.
802. KARHUNEN, K. (1946), "Lineare transformationen stationärer stochastischer Prozesse", *C. R. Dixième Congr. Math. Scand.*, 320-4.
803. KENDALL, D. G. (1947), "A review of some recent work on discontinuous Markoff processes with applications to biology, physics, and actuarial science", *J. R. Statist. Soc.*, **110**, 130-7.
804. KENDALL, M. G. (1945), "Note on Mr. Yule's paper", *J. R. Statist. Soc.*, **108**, 226-30.
805. KENDALL, M. G. (1946), "Contributions to the study of oscillatory time-series", *National Institute of Economic and Social Research. Occasional Papers*, 84.
806. KOLMOGOROFF, A. N. & DMITRIEV, N. A. (1947), "Branching stochastic processes", *C. R. Acad. Sci. U.R.S.S. Doklady*, **56**, 5-8.
807. KOLMOGOROFF, A. N. & SAVOST'YANOV, B. A. (1947), "The calculation of final probabilities for branching random processes", *C. R. Acad. Sci. U.R.S.S. Doklady*, **56**, 783-6.
808. KOSAMBI, D. D. (1943), "Statistics in function space", *J. Indian Math. Soc.*, **7**, 76-88.
809. KOZULYAEV, P. A. (1947), "On a question of extrapolation of stationary random processes", *C. R. Acad. Sci. U.R.S.S. Doklady*, **56**, 903-5.
810. LE CAM (1947), "Un instrument d'étude des fonctions aléatoires: la fonctionnelle caractéristique", *C. R. Acad. Sci. Paris*, **224**, 710-1.
811. LEROY, R. & VAULOT, E. (1945), "Sur la proportion d'appels perdus dans certains systèmes de téléphonie automatique ne permettant dans un groupe d'organes qu'une seule exploration simultanée", *C. R. Acad. Sci. Paris*, **220**, 84-5.
812. LESLIE, P. H. (1945), "On the use of matrices in certain population mathematics", *Biometrika*, **33**, 183-212.
813. LEVINSON, N. (1947), "A heuristic exposition of Wiener's mathematical theory of prediction and filtering", *J. Math. Phys. Mass. Inst. Tech.*, **26**, 110-9.
814. LEVINSON, N. (1947), "The Wiener R.M.S. (root mean square) error criterion in filter design and prediction", *J. Math. Phys. Mass. Inst. Tech.*, **25**, 261-78.
815. LÉVY, P. (1945), "Sur le mouvement brownien dépendant de plusieurs paramètres", *C. R. Acad. Sci. Paris*, **220**, 420-2.
816. LÉVY, P. (1944), "Dérivation, intégration et équations différentielles stochastiques", *C. R. Acad. Sci. Paris*, **219**, 602-3.
817. LÉVY, P. (1944), "Un théorème d'invariance projective relatif au mouvement brownien", *Comment. Math. Helv.*, **16**, 242-8.
818. LÉVY, P. (1946), "Les processus fortement continus et la loi de Laplace", *C. R. Acad. Sci. Paris*, **222**, 839-41.
819. LÉVY, P. (1944), "Une propriété d'invariance projective dans le mouvement brownien", *C. R. Acad. Sci. Paris*, **219**, 378-9.
820. LOÈVE, M. (1945), "Sur la covariance d'une fonction aléatoire", *C. R. Acad. Sci. Paris*, **220**, 295-6.
821. LOÈVE, M. (1946), "Quelques propriétés des fonctions aléatoires de second ordre", *C. R. Acad. Sci. Paris*, **222**, 469-70.
822. LOÈVE, M. (1946), "Sur les fonctions aléatoires vectorielles de second ordre", *C. R. Acad. Sci. Paris*, **222**, 942-4.
823. LOÈVE, M. (1945), "Analyse harmonique générale d'une fonction aléatoire", *C. R. Acad. Sci. Paris*, **220**, 380-2.
824. LOÈVE, M. (1946), "Fonctions aléatoires à décomposition orthogonale exponentielle", *Rev. Sci.*, **84**, 159-62.
825. LOÈVE, M. (1946), "Fonctions aléatoires de second ordre", *Rev. Sci.*, **84**, 195-206.
826. LOVERA, G. (1946), "Sulle coincidenze triple accidentali", *Atti Accad. Naz. Lincei Rend. Cl. Sci. Fis. Mat. Nat.*, **1**, 964-9.
827. LUDERS, R. (1947), "Eine Verallgemeinerung der Formel von Pollaczek-Geiringer und ihre Anwendung auf die Verteilungsfunktion der Hagelschaden", *Z. Angew. Math. Mech.*, **25/27**, 21-8.
828. MALECOT, G. (1944), "Sur un problème de probabilités en chaîne que pose la génétique", *C. R. Acad. Sci. Paris*, **219**, 379-81.
829. MASSÉ, P. (1944), "Sur les principes de la régulation d'un débit aléatoire par un réservoir", *C. R. Acad. Sci. Paris*, **219**, 19-21.

830. MASSÉ, P. (1944), "Sur les effets de la régulation d'un débit aléatoire par un réservoir", *C. R. Acad. Sci. Paris*, **219**, 150-1.
831. MASSÉ, P. (1944), "Sur un cas particulier remarquable de la régulation d'un débit aléatoire par un réservoir", *C. R. Acad. Sci. Paris*, **219**, 173-5.
832. MIHOC, G. (1943), "Sur le problème des itérations dans une suite d'épreuves", *Pull. Math. Soc. Roum. Sci.*, **45**, 81-95.
833. MORAN, P. A. P. (1947), "Some theorems on time series. I", *Biometrika*, **34**, 281-91.
834. MOU, T. C. (1944), "Some mathematical considerations which play a role in diffusion problems", *Ned. Akad. Setensch. Verslagen, Afd. Natuurkunde*, **53**, 400-10.
835. NOLFI, P. (1945), "Zur mathematischen Darstellung wachsender Gesamtheiten", *Mitt. Verein. Schweiz. Versich.-Math.*, **45**, 311-21.
836. NOLFI, P. (1943), "Wahrscheinlichkeit unstetiger Vorgänge bei kontinuierlich wirkenden Ursachen", *Comment. Math. Helvet.*, **15**, 36-44.
837. ONICESCU, O. et MIHOC, G. (1944), "Le coefficient de dispersion et la dépendance des épreuves", *Bull. Math. Soc. Roum. Sci.*, **46**, 77-80.
838. ONICESCU, O. et MIHOC, G. (1943), "Les chaînes de variables aléatoires. Problèmes asymptotiques", *Acad. Roum. Etudes Recherches*, **14**, 167 pp.
839. OPATOWSKI, I. (1945), "Markoff chains with reverse transitions", *Proc. Nat. Acad. Sci. Wash.*, **31**, 411-4.
840. OPATOWSKI, I. (1947), "Simple Markoff chains with reverse transitions: The time moments", *Bull. Amer. Math. Soc.*, **53**, 68-9.
841. OPATOWSKI, I. (1945), "Chain processes and their biophysical applications", *Bull. Math. Biophys.*, **7**, 161-80.
842. OPATOWSKI, I. (1946), "Chain processes and their biophysical applications. II", *Bull. Math. Biophys.*, **8**, 7-15.
843. POLLACZEK, F. (1947), "Sur un problème du calcul des probabilités qui se rapporte à la téléphonie", *J. Math. Pures Appl.*, **25**, 307-34.
844. PITT, H. R. (1946), "A theorem on random functions with applications to a theory of provisioning", *J. Lond. Math. Soc.*, **21**, 16-22.
845. POLYA, G. (1946), "Sur une généralisation d'un problème élémentaire classique, importante dans l'inspection des produits industriels", *C. R. Acad. Sci. Paris*, **222**, 1422-4.
846. QUENOUILLE, M. H. (1947), "Notes on the calculation of autocorrelations of linear autoregressive schemes", *Biometrika*, **34**, 365-7.
847. QUENOUILLE, M. H. (1947), "On the problem of random flights", *Proc. Camb. Phil. Soc.*, **43**, 581-2.
848. RICE, S. O. (1944), "Mathematical analysis of random noise", *Bell Syst. Tech. J.*, **23**, 282-332.
849. RICE, S. O. (1945), "Mathematical analysis of random noise", *Bell Syst. Tech. J.*, **24**, 46-156.
850. RIVLIN, R. S. (1945), "An extension of Campbell's theorem of random fluctuations", *Phil. Mag.*, **7**, 36, 688-93.
851. ROMANOVSKII, V. I. (1946), "On the probabilities of the recurrence of cycles in polycyclic chains", *Acta Univ. Asiae Med. N.S. Fasc.*, **7**, 20 pp.
852. RUARK, A. E. (1944), "Differential equations for the probability distribution of events", *Phys. Rev.*, **65**, 88-90.
853. SAPOGOV, N. A. (1947), "The Laplace-Lyapunov limit theorem for singular Markov chains", *C. R. Acad. Sci. U.R.S.S. Doklady*, **58**, 1905-8.
854. SAPOGOV, N. A. (1947), "On singular Markov chains", *C. R. Acad. Sci. U.R.S.S. Doklady*, **58**, 193-6.
855. SARYMSAKOV, T. (1945), "Un nouveau critère nécessaire et suffisant pour la régularité des chaînes de Markoff dont l'ensemble des états possibles est continu", *C. R. Acad. Sci. U.R.S.S. Doklady*, **49**, 85-8.
856. SARYMSAKOV, T. A. (1945), "Sur les chaînes de Markoff à une infinité dénombrable d'états possibles", *C. R. Acad. Sci. U.R.S.S. Doklady*, **47**, 617-9.
857. SARYMSAKOV, T. A. (1945), "The law of the iterated logarithm for Markov schemes", *Acta Univ. Asiae Med. N.S. Math. Fasc.*, **5**, 15.
858. SARYMSAKOV, T. A. (1945), "Sur les chaînes de Bruns", *C. R. Acad. Sci. U.R.S.S. Doklady*, **49**, 241-3.
859. SCHELLING, H. VON (1944), "Das Alles-oder-Nichts-Gesetz, gedeutet als Endergebnis einer Auslosungsfolge", *Abh. Preuss. Akad. Wiss. Math. Nat.*, **6**, 25.
860. SCHRODINGER, E. (1945), "Probability problems in nuclear chemistry", *Proc. R. Irish Acad. Sect. A.*, **51**, 1-8.
861. SEAL, H. L. (1945), "The mathematics of a population composed of k stationary strata each recruited from the stratum below and supported at the lowest level by a uniform annual number of entrants", *Biometrika*, **33**, 226-30.
862. SILBERSTEIN, L. (1944), "Solution of the restricted problem of the random walk", *Phil. Mag.*, **35**, 538-43.
863. SPENCER-SMITH, J. L. (1947), "The oscillatory properties of the moving average", *J. R. Statist. Soc. Suppl.*, **9**, 104-13.
864. STEIN, C. (1946), "A note on cumulative sums", *Ann. Math. Statist.*, **17**, 498-9.
865. STOCKMAN, C. M. & ARMITAGE, P. (1946), "Some properties of closed sequential schemes", *J. R. Statist. Soc. Suppl.*, **8**, 104-12.
866. TIPPETT, L. H. C. (1944), "The control of industrial processes subject to trends in quality", *Biometrika*, **33**, 163-72.

1951]

867. TORNQVIST, L. (1946), "On the distribution function for a function of n statistic variables and the central limit theorem in the mathematical theory of probability", *Skand. Aktuar. Tidskr.*, 29, 206-29.
868. TWEEDIE, M. C. K. (1945), "Inverse statistical variates", *Nature*, 155, 453.
869. USPENSKY, J. V. (1945), "On the problem of the ruin of gamblers", *Publ. Inst. Mat. Univ. Nac. Litoral*, 7, 155-86.
870. VAJDA, S. (1947), "The stratified semi-stationary population", *Biometrika*, 34, 243-54.
871. WALD, A. (1944), "On cumulative sums of random variables", *Ann. Math. Statist.*, 15, 283-96.
872. WALD, A. (1945), "Some generalisations of the theory of cumulative sums of random variables" *Ann. Math. Statist.*, 16, 287-93.
873. WALD, A. (1946), "Some improvements in setting limits for the expected number of observations required by a sequential ratio test", *Ann. Math. Statist.*, 17, 466-74.
874. WALD, A. (1946), "Differentiation under the expectation sign in the fundamental identity of sequential analysis", *Ann. Math. Statist.*, 17, 493-7.
875. WANG, M. C. & UHLENBECK, G. E. (1945), "On the theory of the Brownian motion. II", *Rev. Mod. Phys.*, 17, 323-42.
876. YAGLOM, A. M. (1947), "On the statistical treatment of Brownian motion", *C. R. Acad. Sci. U.R.S.S. Doklady*, 56, 691-4.
877. YAGLOM, A. M. (1947), "The ergodic principle for Markov processes with stationary distributions", *C. R. Acad. Sci. U.R.S.S. Doklady*, 56, 347-9.
878. YAGLOM, A. M. (1947), "Certain limit theorems of the theory of branching random processes", *C. R. Acad. Sci. U.R.S.S. Doklady*, 56, 795-8.
879. YULE, G. U. (1945), "On a method of studying time series based on their internal correlations" *J. R. Statist. Soc.*, 108, 208-25.

6.1. Foundations.

880. BOCHNER, S. (1946), "Finitely additive set functions and stochastic processes", *Proc. Nat. Acad. Sci. Wash.*, 32, 259-61.
881. BOCHNER, S. (1947), "Stochastic processes", *Ann. Math.*, 48, 1014-61.
882. DEDEBANT, G. & WEHRLE, P. (1945), "Mécanique aléatoire. I. Le calcul aléatoire (suite). II. Applications physiques", *Portugaliae Phys.*, 1, 179-296.
883. DEDEBANT, G. & WEHRLE, P. (1944), "Mécanique aléatoire. I. Le calcul aléatoire", *Portugaliae Phys.*, 1, 95-149.
884. DOOB, J. L. (1947), "Probability in function space", *Bull. Amer. Math. Soc.*, 53, 15-30.
885. KAMPE DE FERIET, J. (1947), "Sur une représentation des fonctions aléatoires", *C. R. Acad. Sci. Paris*, 225, 37-8.
886. KAMPE DE FERIET, J. (1947), "Fonctions aléatoires définies sur un groupe abstrait", *C. R. Acad. Sci. Paris*, 225, 428-9.
887. NAKANO, H. (1944), "Über stochastischen prozess. I", *Proc. Imp. Acad. Japan*, 20, 513-8.

6.2. Properties of Processes

888. BLACKWELL, D. & GIRSHICK, M. A. (1946), "On functions of sequences of independent chance vectors with applications to the problem of the 'random walk' in k dimensions", *Ann. Math. Statist.*, 17, 310-7.
889. BLANC-LAPIERRE, A. et LAPOSTOLLE, P. (1946), "Propagation d'une perturbation à spectre peu étendu dans un milieu dispersif non absorbant", *Revue Sci.*, 84, 579-95.
890. CRAMER, H. (1946), "On the theory of stochastic processes", *C. R. Dixième Congr. Math. Scand.*, 28-39.
891. FURTH, R. & MACDONALD, D. K. C. (1947), "Statistical analysis of spontaneous electrical fluctuations", *Proc. Phys. Soc.*, 59, 388-408.
892. HURWICZ, L. (1944), "Stochastic models of economic fluctuations", *Econometrica*, 12, 114-24.
893. MONTROLL, E. W. (1947), "On the theory of Markoff chains", *Ann. Math. Statist.*, 18, 18-36.
894. SARYMSAKOV, T. A. (1945), "Sur une synthèse des deux méthodes d'exposer la théorie des chaînes discrètes de Markoff", *C. R. Acad. Sci. U.R.S.S. Doklady*, 48, 159-61.
895. VILLE, J. (1943), "Sur les processus stochastiques stationnaires analytiques", *C. R. Acad. Sci. Paris*, 217, 101-3.
896. WIENER, N. (1945), "The theory of statistical extrapolation", *Bol. Soc. Mat. Mexicana*, 2, 37-42.

6.21. More Specific Applications of Properties of Processes

897. ASCOLI, G. (1947), "Sopra una valutazione asintotica che si presenta nella teoria probabilistica dei contatori di corpuscoli", *Ricerca Sci.*, 17, 611-6.
898. BASS, J., DEDEBANT, G. & WEHRLE, P. (1945), "Sur la connexion aléatoire d'un fluide. Application à la turbulence", *C. R. Acad. Sci. Paris*, 220, 165-7.
899. BERLOVICH, E. (1946), "Statistics of misses in Geiger-Müller counters", *Akad. Nauk. S.S.S.R. Zhurnal Eksper. Teoret. Fiz.*, 16, 543-6.
900. BERLOVICH, E. (1946), "The theory of misses in an electromagnetic numerator at the output of a dividing scheme with a Geiger-Müller counter", *Akad. Nauk. S.S.S.R. Zhurnal Eksper. Teoret. Fiz.*, 15, 547-52.

901. BRARD, R. (1944), "Interdépendance du tourbillon moyen local et de la vitesse moyenne locale d'agitation dans les mouvements turbulents", *C. R. Acad. Sci. Paris*, **218**, 144-6.
902. BRARD, R. (1944), "Sur la répartition du tourbillon dans un écoulement turbulent statistiquement permanent", *C. R. Acad. Sci. Paris*, **219**, 604-5.
903. BUCHMAN, E. N. (1947), "The problem of waiting time", *Akad. Nauk. S.S.S.R. Prikl. Mat. Mech.*, **11**, 475-84.
904. CRAMÉR, H. (1946), "Lundberg's risk theory and the theory of stochastic processes", *Förs. Mat. Stud. Lundberg*, 25-31. Stockholm.
905. DAVIDSON, A. (1946), "On the problem of ruin in the collective risk theory under the assumption of variable safety loading", *Förs. Mat. Stud. Lundberg*, 32-47. - Stockholm.
906. DRYDEN, H. L. (1943), "A review of the statistical theory of turbulence", *Quart. Appl. Math.*, **1**, 7-42.
907. FEATHER, N. (1943), "On the statistics of random distributions of paired events, with applications to the results obtained in the use of the interval selector with particle counters", *Proc. Camb. Phil. Soc.*, **39**, 84-99.
908. HOLE, N. (1947), "On the distribution of counts in a counting apparatus", *Ark. Mat. Astr. Fys.*, **33B**, (8), 8.
909. HOLE, N. (1946), "On the statistical treatment of counting experiments in nuclear physics", *Ark. Mat. Astr. Fys.*, **33A** (11), 11.
910. HOLE, N. (1947), "Note on the statistical analysis of counter data", *Ark. Mat. Astr. Fys.*, **34B**, (12) 8.
911. ITÔ, K. (1944), "A kinematic theory of turbulence", *Proc. Imp. Acad. Japan*, **20**, 120-2.
912. JANOSSY, L. (1944), "Rate of n -fold accidental coincidences", *Nature*, **153**, 165.
913. JOST, R. (1947), "Bemerkungen zur mathematischen Theorie der Zähler", *Helv. Phys. Acta*, **20**, 173-82.
914. KOSTEN, L. (1943), "On the frequency distribution of the number of discharges counted by a Geiger-Müller counter in a constant interval", *Physica*, **10**, 749-56.
915. KRONIG, R. (1943), "On the losses in machinery undergoing interruptions", *Physica*, **10**, 215-24.
916. KRONIG, R. & MONDRIA, H. (1943), "On time losses in machinery undergoing interruptions, II", *Physica*, **10**, 331-6.
917. KURBATOV, J. D. & MANN, H. B. (1945), "Correction of Geiger-Müller counter data", *Phys. Rev.*, **68**, 40-3.
918. LEVERT, C. & SCHEEN, W. L. (1943), "Probability fluctuations of discharges in a Geiger-Müller counter produced by cosmic radiation", *Physica*, **10**, 225-38.
919. LOVERA, G. (1947), "Sullo scarto quadratico medio nei conteggi con i contatori", *Ricerca Sci.*, **17**, 223-8.
920. MALMQUIST, S. (1947), "A statistical problem connected with the counting of radioactive particles", *Ann. Math. Statist.*, **18**, 255-64.
921. MANN, H. B. (1946), "A note on the correction of Geiger-Müller counter data", *Quart. Appl. Math.*, **4**, 307-9.
922. MARET, A. (1947), "De la fonction d'événement d'un ensemble ouvert variable", *Mitt. Verejn. Schweiz. Versich. Math.*, **47**, 321-7.
923. OSIDA, I. (1943), "Statistical theory of transport phenomena", *Proc. Phys.-Math. Soc. Japan*, **25**, 590-4.
924. PALM, C. (1943), "Intensitätsschwankungen im Fernsprechverkehr", *Ericsson Technics*, **44**, 189.
925. POLLACZEK, F. (1946), "The law of delay in telephone calls", *C. R. Acad. Sci. Paris*, **222**, 353-5.
926. POLLACZEK, F. (1946), "Sur l'application de la théorie des fonctions au calcul de certaines probabilités continues utilisées dans la théorie des réseaux téléphoniques", *Ann. Inst. Poincaré*, **10**, 1-55.
927. SIMAIKA, J. B. (1947), "On the significance of a typical value in the renewal theory", *Skand. Aktuar. Tidskr.*, **30**, 121-9.
928. SIMONSEN, W. (1946), "On the foundation of the collective risk theory", *Förs. Mat. Stud. Lundberg*, 246-64. Stockholm.
929. VAULOT, E. (1946), "Waiting delays of telephone calls receiving attention at random", *C. R. Acad. Sci. Paris*, **222**, 268-9.
930. VLADIMIRSKY, V. & TERLETSKY, J. (1945), "Hydrodynamical theory of translational Brownian motion", *Akad. Nauk. S.S.S.R. Zhurnal Eksper. Teoret. Fiz.*, **15**, 258-63.

6.3. Estimation Problems and Tests of Hypotheses

931. ANDERSON, T. W. (1947), "A note on a maximum-likelihood estimate", *Econometrica*, **15**, 241-4.
932. BARTLETT, M. S. (1946), "On the theoretical specification and sampling properties of autocorrelated time-series", *J. R. Statist. Soc. Suppl.*, **8**, 27-41.
933. BAYLEY, G. V. & HAMMERSLEY, J. M. (1946), "The 'effective' number of independent observations in an autocorrelated time series", *J. Roy. Statist. Soc. Suppl.*, **8**, 184-97.
934. GLEISSBERG, W. (1945), "Ein Kriterium für die Realität zyklischer Variationen", *Rev. Fac. Sci. Univ. Istanbul*, **10**, 36-42.
935. KELLY, T. L. (1943), "The evidence for periodicity in short time series", *J. Amer. Statist. Ass.*, **38**, 319-26.
936. KENDALL, M. G. (1944), "On autoregressive time series", *Biometrika*, **33**, 105-22.
937. KENDALL, M. G. (1945), "On the analysis of oscillatory time-series", *J. R. Statist. Soc.*, **108**, 93-124.
938. MANN, H. B. & WALD, A. (1943), "On the statistical treatment of linear stochastic difference equations", *Econometrica*, **11**, 173-220.
939. MOORE, G. H. & WALLIS, W. A. (1943), "Time series significance tests based on signs of differences", *J. Amer. Statist. Ass.*, **38**, 153-64.

1951]

940. QUENOUILLE, M. H. (1947), "A large sample test for the goodness of fit of autoregressive schemes", *J. R. Statist. Soc.*, **110**, 123-9.
941. SMITH, J. L. S. (1944), "The specification of disturbed periodic time series of the type of Wolfer's annual sunspot numbers", *J. R. Statist. Soc.*, **107**, 231-41.

C. APPLICATIONS

1. BIOLOGY

P. ARMITAGE

1.1. Human Populations

942. BAILLIE, D. C. (1946), "On testing the significance of mortality ratios by the use of χ^2 ", *Trans. Actuar. Soc. Amer.*, **47**, 326-44, 541-61.
943. BEARD, R. E. (1947), "The standard deviation of the distribution of sickness", *J. Inst. Actu. Stud. Soc.*, **7**, 23-8.
944. BUCKATZSCH, E. J. (1947), "The influence of social conditions on mortality rates", *Pop. Studies*, **1**, 229-48.
945. BURNENS, E. (1947), "Die Erfahrungsnachwirkung bei Wahrscheinlichkeiten", *Mitt. Ver. Schweiz. VersichMath.*, **447**, 329-52.
946. BRUYERE, P. T., BRUYERE, M. C. & GLEESON, G. A. (1946), "The use of $2 \times n$ chi square in the analysis of change in age distributions", *Amer. J. Publ. Hlth.*, **36**, 510-14.
947. CAMPAGNE, C. (1943), "De stelling van Hattendorf en haar algemeene geldigheid door de stelling van Cantelli", *Verz.-Arch.*, **24**, 121-44.
948. CAMPBELL, G. C. (1945), "A study of the variance of the observed death-rate when the exposure is estimated from a sample", *Trans. Actuar. Soc. Amer.*, **46**, 59-68.
949. CARLETON, J. (1945), "Non-random accident distributions and the Poisson series", *Proc. Casualty Actuar. Soc. Amer.*, **32**, 21-6.
950. CLARK, C. & DYNE, R. E. (1946), "Applications and extensions of the Karmel formula for reproductivity", *Econ. Record (Melbourne)*, **22**, 23-39.
951. CLAUSEN, J. A. & FORD, R. N. (1947), "Controlling bias in mail questionnaires", *J. Amer. Statist. Ass.*, **42**, 497-511.
952. COATES, R. P. & CODY, D. D. (1946), "Observations on exposure sampling procedures", *Trans. Actuar. Soc. Amer.*, **47**, 311-25.
953. CORNELL, F. G. (1947), "A stratified-random sample of a small finite population", *J. Amer. Statist. Ass.*, **42**, 523-40.
954. COWDEN, D. J. (1947), "Simplified methods of fitting certain types of growth curves", *J. Amer. Statist. Ass.*, **42**, 585-90.
955. DAHLBERG, G. (1943), "Mathematische Erblichkeitsanalyse von Populationen", *Acta med. scand. Suppl.*, **148**, 3-219.
956. DAW, F. H. (1945), "On the validity of statistical tests of the graduation of a mortality table", *J. Inst. Actuar.*, **72**, 174-202.
957. ELDETON, W. P. & OGBORN, M. E. (1943), "The mortality of adult males since the middle of the eighteenth century as shown by the experience of life assurance companies", *J. R. Statist. Soc.*, **106**, 1-20.
958. FRANCKX, E. (1945), "L'évolution des collectivités", *Mitt. Ver. Schweiz. VersichMath.*, **45**, 279-88.
959. FRÉCHET, M. (1947), "Sur les expressions analytiques de la mortalité valables pour la vie entière", *J. Soc. Statist. Paris*, **88**, 261-85.
960. FREUDENBERG, K. (1945), "Zur Ausgleichung doppelt abgestufter Sterbetafeln", *Verz.-Arch.*, **26**, 69-100.
961. DE GEUS, W. (1944), "Invloed van rente-uitstel op de slotwaarde van een kapitaal", *Verz.-Arch.*, **25**, 73-96.
962. GINI, C. (1943), "A co-ordination of the different population theories", *Rev. Inst. Int. Statist.*, **11**, 35-67.
963. GRABILL, W. H. (1945), "Attrition life tables for the single population", *J. Amer. Statist. Ass.*, **40**, 364-75.
964. GREVILLE, T. N. E. (1943), "Short methods of constructing abridged life tables", *Rec. Amer. Inst. Actuar.*, **32**, 29-43.
965. GREVILLE, T. N. E. (1943), "'Census' methods of construction of mortality tables and their relation to 'insurance' methods", *Rec. Amer. Inst. Actuar.*, **32**, 125-30.
966. GREVILLE, T. N. E. (1947), "Actuarial note: Adjusted average graduation formulas of maximum smoothness", *Rec. Amer. Inst. Actuar.*, **36**, 249-64.
967. GUMBEL, E. J. (1946), "Probability of death and expectation of life", *Hum. Biol.*, **18**, 238-40.
968. HAAK, L. A. (1943), "A new method of analysing the age and sex composition of a population", *Proc. Okla. Acad. Sci.*, **23**, 84-5.
969. HAGOOD, M. J. (1947), "Recent contributions of statistics to research methodology in sociology", *Social Forces*, **26**, 36-40.
970. HAJNAL, J. (1947), "The analysis of birth statistics in the light of the recent international recovery of the birth rate", *Pop. Studies*, **1**, 137-64.

971. HERSCH, L. (1940), "De quelques potentiels-vie et de certaines variétés de vie moyenne", *Rev. Inst. int. Statist.*, **8**, 128-62.
972. HERSCH, L. (1942), "La méthode des potentiels-vie appliquée à l'étude du mouvement naturel de la population", *Rev. Inst. int. Statist.*, **10**, 152-83.
973. HERSCH, L. (1944), "Quelques précisions sur la méthode des potentiels-vie et ses notions fondamentales", *Rev. Inst. int. Statist.*, **12**, 23-35.
974. HERSCH, L. (1944), "De la démographie actuelle à la démographie potentielle", *Mélanges d'études écon. soc. offerts à W. E. Rappard, Geneva*, 55-129.
975. JANER, J. L. (1945), "Population growth in Puerto Rico and its relation to time changes in vital statistics", *Hum. Biol.*, **17**, 267-313.
976. JESSEN, R. J., BLYTHE, R. H., KEMP THORNE, O. & DEMING, W. E. (1947), "On a population sample for Greece", *J. Amer. Statist. Ass.*, **42**, 357-84.
977. JOSEPH, A. W. (1946), "The valuation of whole-life assurances by the use of moments", *J. Inst. Actu.*, **72**, 498-515.
978. KARMEL, P. H. (1947), "The relations between male and female reproduction rates", *Pop. Studies*, **1**, 249-74.
979. KARPINOS, B. D. (1946), "Use of life table death rates for comparative mortality", *Hum. Biol.*, **18**, 127-31.
980. KELLER, J. D. (1946), "Growth curves of nations", *Hum. Biol.*, **18**, 204-20.
981. KENDALL, D. G. (1947), "A review of some recent work on discontinuous Markoff processes with applications to biology, physics and actuarial science", *J. R. Statist. Soc.*, **110**, 130-7.
982. LANG, K. (1943), "Analysis of net premium formulas for the income endowment policy", *Rec. Amer. Inst. Actuar.*, **32**, 156-70.
983. LIENAU, C. C. (1947), "Quantitative aspects of organization", *Hum. Biol.*, **19**, 163-216.
984. LOTKA, A. J. (1945), "Population analysis as a chapter in the mathematical theory of evolution", In: "Essays on growth and form" presented to D'Arcy Wentworth Thompson O.U.P. 355-85.
985. VAN DER MAËN, W. J. (1943), "Het berekenen van sterftekansen", *Verz.-Arch.*, **24**, 281-300.
986. MARET, A. (1947), "De la fonction d'événement d'un ensemble ouvert variable", *Mitt. Ver. schweiz. VersichMath.*, **47**, 321-7.
987. MCCORMICK, T. C. (1945), "Note on the validity of mathematical probability in sociological research", *Am. Sociol. Rev.*, **10**, 626-31.
988. MARSHALL, E. W. (1945), "Principles underlying exposed to risk formulae", *Trans. Actuar. Soc. Amer.*, **46**, 10-50.
989. MARTIN, W. J. (1944), "The sex ratio of pneumonia mortality", *J. Hyg., Camb.*, **43**, 315-27.
990. MATHEW, N. T. (1946), "Factors influencing the relative proportion at birth of the two sexes", *Sankhyā*, **8**, 277-81.
991. MERRELL, M. (1947), "Time-specific life tables contrasted with observed survivorship", *Biometrics*, **3**, 129-36.
992. MEYER, W. (1943), "De actuariële behandeling van subnormale risico's", *Verz.-Arch.*, **24**, 214-26.
993. MICHALUP, E. (1946), "El promedio de la duración de la vida y la función de Pym", *Estadist.*, **4**, 252-9.
994. MYERS, R. J. (1943), "A note on the variance of sex ratios", *Hum. Biol.*, **15**, 267-70.
995. NIEDERMANN, H. (1946), "Untersuchungen über den Wahrscheinlichkeitscharakter der Sterblichkeit", *Mitt. Ver. schweiz. VersichMath.*, **46**, 131-68.
996. NOLFI, P. (1944), "Zur Bestimmung der Ruckschlusswahrscheinlichkeit einer geschlossenen Gesamtheit", *Mitt. Ver. schweiz. VersichMath.*, **44**, 217-20.
997. PERKS, W. (1946), "Two-variable developments of the n -ages method", *J. Inst. Actu.*, **72**, 377-414.
998. RHODES, F. (1946), "Percentage table for the estimation of sickness rates for special periods of sickness", *J. Inst. Actu.*, **72**, 455-69.
999. ROMER, B. (1947), "Die Bestimmung von durchschnittlichen Krankenkosten an Stichproben", *Mitt. Ver. schweiz. VersichMath.*, **47**, 249-71.
1000. VAN ROOIJEN, J. P. (1944), "De logistische functie in de Nederlandsche sterftestatistiek", *Verz.-Arch.*, **25**, 1-32.
1001. RUTHERFORD, C. D. (1946), "Actuarial mathematics and statistics", In: "Proc. 1st Canad. Math. Congr. Montreal 1945". Toronto, Univ. Press, 25-30.
1002. SEAL, H. L. (1945), "The mathematics of a population composed of k stationary strata each recruited from the stratum below and supported at the lowest level by a uniform annual number of entrants", *Biometrika*, **33**, 226-30.
1003. SEAL, H. L. (1947), "A historical note on the use of Chi square to test the applicability of a mortality table graduation", *J. Inst. Actu. Stud. Soc.*, **6**, 185-7.
1004. SEAL, H. L. (1947), "Multiple decrement tables and the force of mortality—a historical note", *J. Inst. Actu. Stud. Soc.*, **6**, 197-9.
1005. SEAL, H. L. (1947), "A probability distribution of deaths at age x when policies are counted instead of lives", *Skand. Aktuar. Tidskr.*, **30**, 18-43.
1006. SHANNON, S. (1943), "A theory of automatic premium-loan approximations: Formulas derived and compared", *Rec. Amer. Inst. Actuar.*, **32**, 74-82.
1007. SHAUL, J. R. H. (1946), "Derivation of total fertility, gross and net reproduction rates from census statistics of marriage fertility", *J. R. Statist. Soc.*, **109**, 278-83.
1008. SIMAIKA, J. B. (1947), "On the significance of a typical value in the renewal theory", *Skand. Aktuar. Tidskr.*, **30**, 121-9.

1951]

1009. SIMONSEN, W. (1943), "On the construction of biometric functions from the experience of life insurance companies", *Skand. Aktuar. Tidskr.*, **26**, 145-75.
1010. SOLOMON, L. (1947), "Integral equations: some applications to actuarial science", *Trans. Fac. Actuar. Edin.*, **18**, 139-65.
1011. STAUBER, K. (1947), "Begriff und Verwendung des Reduktionsfaktors in der Krankenversicherung", *Mitt. Ver. schweiz. VersichMath.*, **47**, 273-80.
1012. STEFFENSEN, J. F. (1944), "On the construction of tables for the calculation of certain survivorship benefits", *Skand. Aktuar. Tidskr.*, **27**, 154-71.
1013. STERN, C. (1943), "The Hardy-Weinberg Law", *Science*, **97**, 137-8.
1014. STEWART, D. C. (1945), "Significance tests for industrial injury rates", *Edison Elect. Inst. Bull.*, **13**, 361-3.
1015. STEWART, J. Q. (1947), "Empirical mathematical rules concerning the distribution and equilibrium of population", *Geogr. Rev.*, **37**, 461-85.
1016. STRANDSKOV, H. H. (1942), "On the variance of human live birth sex ratios", *Hum. Biol.*, **14**, 85-94.
1017. SUNDSTRÖM, M. (1944), "Untersuchung über die Kränklichkeit in den staatlich unterstützten Krankenkassen Schwedens", *Skand. Aktuar. Tidskr.*, **27**, 177-228.
1018. TÄCKLIND, S. (1944), "Elementare Behandlung vom Erneuerungsproblem für den stationären Fall", *Skand. Aktuar. Tidskr.*, **27**, 1-15.
1019. TÄCKLIND, S. (1945), "Fourieranalytische Behandlung vom Erneuerungsproblem", *Skand. Aktuar. Tidskr.*, **28**, 68-105.
1020. VAJDA, S. (1945), "The analysis of variance of mortality rates", *J. Inst. Actu.*, **72**, 240-5.
1021. VAJDA, S. (1947), "The stratified semi-stationary population", *Biometrika*, **34**, 243-54.
1022. VENEMA, W. (1944), "De integraalvergelijkingen voor de premiereserve van de spaarverzekering", *Verz.-Arch.*, **25**, 53-61.
1023. VINCENT, P. (1946), "De la mesure du taux intrinsèque d'accroissement naturel dans les populations monogames", *Population*, **1**, 699-712.
1024. WECK, F. A. (1947), "The mortality rate and its derivation from actual experience", *Rec. Amer. Inst. Actuar.*, **36**, 23-54.
1025. WHELPTON, P. K. (1946), "Reproduction rates adjusted for age, parity, fecundity, and marriage", *J. Amer. Statist. Ass.*, **41**, 501-16.
1026. WINKLER, W. (1944), "Die Lebensjahre einer Bevölkerung", *Rev. Inst. Int. Statist.*, **12**, 5-22.
1027. WOOFER, T. J. (1946), "Probability of death in closed population groups. Illustrated by probability of death of white fathers after birth of children", *Hum. Biol.*, **18**, 158-70.
1028. WOOLFE, B. & WATERHOUSE, J. (1945), "Studies in infant mortality. I. Influence of social conditions in county boroughs of England and Wales", *J. Hyg., Camb.*, **44**, 67-98.
1029. YATES, F. (1946), "A review of recent statistical developments in sampling and sampling surveys", *J. R. Statist. Soc.*, **109**, 12-30.

1.2. Animal and Microbial Populations

1030. DE BACH, P. & SMITH, H. S. (1947), "Effects of parasite population density on rate of change of host and parasite populations", *Ecology*, **28**, 290-8.
1031. BACHI, R. (1947), "Statistical analysis of data; based upon: 'The attraction of mosquitoes by human beings', by G. Mer, D. Birnbaum and A. Aioub", *Parasitology*, **38**, 5-9.
1032. BALDI, E. (1943), "Numero stazionario di una popolazione naturale confinata", *Atti Soc. ital. Sci. nat.*, **82**, 309-17.
1033. BOWEN, M. F. (1947), "Population distribution of the beet leafhopper relation to experimental field-plot layout", *J. Agric. Res.*, **75**, 259-78.
1034. CHENG, C. (1942), "On the fecundity of some gammerids", *J. Mar. Biol. Ass. U.K.*, **25**, 467-74.
1035. COLE, L. C. (1946), "A theory for analyzing contagiously distributed populations", *Ecology*, **27**, 329-41.
1036. DALLA VALLE, J. M. (1941), "Note on the 'most probable number' index as used in bacteriology", *Publ. Hlth. Rep.*, **56**, 229-34.
1037. DELBRÜCK, M. (1944), "A statistical problem", *J. Tenn. Acad. Sci.*, **19**, 177-8.
1038. DELBRÜCK, M. (1945), "Spontaneous mutations of bacteria", *Ann. Mo. Bot. Gdn.*, **32**, 223-33.
1039. DE LURY, D. B. (1947), "On the estimation of biological populations", *Biometrics*, **3**, 145-67.
1040. DICE, L. R. (1945), "Measures of the amount of ecologic association between species", *Ecology*, **26**, 297-302.
1041. DOBZHANSKY, T. & WRIGHT, S. (1943), "Genetics of natural populations. X. Dispersion rate in *Drosophila pseudo-obscura*", *Genetics*, **28**, 304-40.
1042. EISENHART, C. & WILSON, P. W. (1943), "Statistical methods and control in bacteriology", *Bact. Rev.*, **7**, 57-137.
1043. ERICKSON, R. O. & STEHN, J. R. (1945), "A technique for analysis of population density data", *Amer. Midl. Nat.*, **33**, 781-7.
1044. FINNEY, D. J. (1946), "Field sampling for the estimation of wireworm populations", *Biometrics Bull.*, **2**, 1-11.
1045. FISHER, R. A., CORBET, A. S. & WILLIAMS, C. B. (1943), "The relation between the number of species and the number of individuals in a random sample of an animal population", *J. Anim. Ecol.*, **12**, 42-58.
1046. FOERSTER, R. E. & RICKER, W. E. (1941), "The effect of reduction of predaceous fish on survival of young sockeye salmon at Cultus Lake", *J. Fish. Res. Board Canada*, **5**, 315-36.

1047. HACKER, H. P. & PEARSON, H. S. (1944), "The growth, survival, wandering and variation of the long-tailed field-mouse, *Apodemus sylvaticus*. I. Growth", *Biometrika*, **33**, 136-62.
1048. HACKER, H. P. & PEARSON, H. S. (1946), "The growth, survival, wandering and variation of the long-tailed field-mouse, *Apodemus sylvaticus*. II. Survival", *Biometrika*, **33**, 333-61.
1049. HANNAY, C. L. (1946), "A control chart for bacterial colony counts", *Proc. Soc. Appl. Bact.*, **85**.
1050. HARRISON, J. L. (1945), "Stored products, and the insects infesting them as examples of the logarithmic series", *Ann. Eugen., Lond.*, **12**, 280-2.
1051. HUTCHINSON, G. E. (1947), "A note on the theory of competition between two social species", *Ecology*, **28**, 319-21.
1052. IVLEV, V. S. (1944), "The relationship between time of hunting in predaceous fish and density of population of their prey", *Zool. Zh.*, **23**, 139-45.
1053. JACKSON, C. H. N. (1944), "The analysis of a tsetse-fly population. II", *Ann. Eugen., Lond.*, **12**, 176-205.
1054. JAHN, J., SCHMID, C. F. & SCHRAG, C. (1947), "The measurement of ecological segregation", *Amer. Sociol. Rev.*, **12**, 293-303.
1055. JENNISON, M. W. & WADSWORTH, G. P. (1940), "Evaluation of the errors involved in estimating bacterial numbers by the plating method", *J. Bact.*, **39**, 389-97.
1056. JONES, E. W. (1945), "Index of diversity as applied to ecological problems", *Nature, Lond.*, **155**, 390.
1057. JONES, F. G. W. (1945), "Soil populations of beet elworm (*Heterodera schachtii* Schm.) in relation to cropping", *Ann. Appl. Biol.*, **32**, 351-80.
1058. KELKER, G. H. (1947), "Computing the rate of increase for deer", *J. Wildlife Management*, **11**, 177-83.
1059. KLAUBER, L. M. (1943), "The correlation of variability within and between rattlesnake populations", *Copeia*, **2**, 115-8.
1060. KLAUBER, L. M. (1945), "Herpetological correlations. I. Correlations in homogeneous populations", *Bull. Zool. Soc. S. Diego*, **21**, 1-101.
1061. LESLIE, P. H. (1945), "On the use of matrices in certain population mathematics", *Biometrika*, **33**, 183-212.
1062. LURIA, S. E. & DELBRÜCK, M. (1943), "Mutations of bacteria from virus sensitivity to virus resistance", *Genetics*, **28**, 491-511.
1063. MILNE, A. (1943), "The comparison of sheep-tick populations (*Ixodes ricinus* L.)", *Ann. Appl. Biol.*, **30**, 240-50.
1064. MOTTLEY, C. MCC. (1943), "Modern methods of studying fish populations", *Trans. N. Amer. Wildlife Conf.*, **7**, 356-60.
1065. PARK, T. (1945), "Life tables for the black flour beetle, *Tribolium madens* Charp.", *Amer. Nat.*, **79**, 436-44.
1066. PREBBLE, M. L. (1943), "Sampling methods in population studies of the European spruce sawfly, *Gilpinia hercyniae* (Hartig) in eastern Canada", *Trans. Roy. Soc. Can. Sect.*, **5**, Ser. 3, 37, 93-126.
1067. RAO, W. V. B. S., DESAI, S. V. & REDDY, M. K. (1945), "Studies in the methods of estimating total bacterial counts in the soil", *Indian J. Agric. Sci.*, **15**, 111-5.
1068. RICH, W. H. (1943), "An application of the control chart method to the analysis of fisheries data", *Science*, **97**, 269-70.
1069. RICKER, W. E. (1944), "Further notes on fishing mortality and effort", *Copeia*, **1**, 23-44.
1070. RICKER, W. E. (1945), "Some applications of statistical methods to fishery problems", *Biometrics Bull.*, **1**, 73-9.
1071. ROBERTSON, F. W. & SANG, J. H. (1944), "The ecological determinants of population growth in a *Drosophila* culture. I. Fecundity of adult flies. II. Circumstances affecting egg viability", *Proc. Roy. Soc., Ser. B*, **132**, 258-91.
1072. ROSENBLATT, A. (1944), "Sobre la aplicacion de la estadistica matematica a la bacteriologia. I. Metodo de dilucion de Louis Pasteur: Caso de una unica dilucion: Aplicacion de la segunda ley de P. S. Laplace", *Rev. Univ. nac. Tucuman*, **A4**, 217-34.
1073. SAVAGE, G. M. & HALVORSON, H. O. (1941), "The effect of culture environment on results obtained with the dilution method of determining bacterial population", *J. Bact.*, **41**, 355-62.
1074. SCHUMACHER, F. X. & ESCHMEYER, R. W. (1943), "The estimate of fish populations in lakes or ponds", *J. Tenn. Acad. Sci.*, **18**, 228-49.
1075. SHAPIRO, A. (1946), "The kinetics of growth and mutation in bacteria", *Cold Spr. Harb. Symp. Quant. Biol.*, **11**, 228-34.
1076. SUN, Y.-P. & SHEPARD, H. H. (1947), "Methods of calculating and correcting the mortality of insects", *J. Econ. Ent.*, **40**, 710-5.
1077. VESTAL, A. G. (1943), "Unequal scales for rating species in communities", *Amer. J. Bot.*, **30**, 305-10.
1078. WADLEY, F. M. (1945), "An application of the Poisson series to some problems of enumerations", *J. Amer. Statist. Ass.*, **40**, 85-92.
1079. WADLEY, F. M. (1945), "Incomplete block experimental designs in insect population problems", *J. Econ. Ent.*, **38**, 651-4.
1080. WADLEY, F. M. (1946), "Incomplete-block design adapted to paired tests of mosquito repellents", *Biometrics Bull.*, **2**, 30-1.
1081. WADLEY, F. M. & WOLFENBARGER, D. O. (1944), "Regression of insect density on distance from centre of dispersion as shown by a study of the smaller European elm bark beetle", *J. Agric. Res.*, **69**, 299-308.
1082. WILLIAMS, C. B. (1943), "Area and number of species", *Nature, Lond.*, **152**, 264-7.

1951]

1083. WILLIAMS, C. B. (1945), "Recent light trap catches of lepidoptera in U.S.A. analysed in relation to the logarithmic series and the index of diversity", *Ann. Ent. Soc. Amer.*, **38**, 357-64.
 1084. WILLIAMS, C. B. (1945), "Index of diversity as applied to ecological problems", *Nature, Lond.*, **155**, 390-1.
 1085. WILLIAMS, C. B. (1947), "The logarithmic series and its application to biological problems", *J. Ecol.*, **34**, 1-20.

1.3. Allometry and Anthropology

1086. APPEL, F. W. & APPEL, E. M. (1942), "Intercranial variation in the weight of the human brain", *Hum. Biol.*, **14**, 48-68, 235-50.
 1087. BAKER, G. A. (1944), "Weight-growth curves", *Poult. Sci.*, **23**, 83-90.
 1088. BAKER, G. A. (1943), "Length-growth curves for the razor clam", *Growth*, **7**, 439-43.
 1089. BAKER, G. A. (1945), "Graduation of human growth curves", *Growth*, **9**, 299-302.
 1090. BIRD, S. (1945), "Measuring roundness of breast in live turkeys", *U.S. Egg Poult. Mag.*, **51**, 206-9, 235.
 1091. BURT, C. (1947), "Factor analysis of physical types", *Psychometrika*, **12**, 171-88.
 1092. BURT, C. & BANS, C. (1947), "A factor analysis of body measurements for British adult males", *Ann. Eugen., Lond.*, **13**, 238-56.
 1093. CAMPBELL, J. A. & EMSLIE, A. R. G. (1947), "Variability in chick growth data", *Poult. Sci.*, **26**, 573-5.
 1094. CHOWHAN, J. S. & AIYER, S. J. (1946), "Analysis of data regarding physical measurements on men examined for army, technical recruits from South India", *Sankhyā*, **8**, 79-81.
 1095. COUNT, E. W. (1942), "A quantitative analysis of growth in certain human skull dimensions", *Hum. Biol.*, **14**, 143-65.
 1096. COUNT, E. W. (1943), "Growth patterns of the human physique: An approach to kinetic anthropometry. Part 1", *Hum. Biol.*, **15**, 1-32.
 1097. DAMON, A. (1942), "A note on the estimation of dysplasia in human physiques: Sheldon's method and the analysis of variance", *Hum. Biol.*, **14**, 110-2.
 1098. DAVIES, O. L. (1947), "Statistical evaluation of growth curves", *Proc. Soc. Exp. Biol.*, **66**, 567-8.
 1099. DUNN, M. S., MURPHY, E. A. & ROCKLAND, L. B. (1947), "Optimal growth of the rat", *Physiol. Rev.*, **27**, 72-94.
 1100. GRAY, H. (1945), "Heart-weight and body-weight in rodents", *J. Mammal.*, **26**, 285-99.
 1101. GRAY, H. & MAHAN, E. (1943), "Prediction of heart weight in man", *Amer. J. Phys. Anthropol.*, **1**, 271-87.
 1102. HAYWARD, J. F. (1943), "An application of the principles of allometry to the study of English senonian Echinocorys", *Nature, Lond.*, **151**, 617.
 1103. HERSH, A. H. (1943), "A further application of the allometric equation", *Anat. Rec.*, **87**, 19-20.
 1104. LE HEUX, J. W. N. (1947), "The growth-curve", *Proc. kon. ned. Akad. v. Wet.*, **50**, 1201-13.
 1105. HOPKINS, J. W. (1947), "Height and weight of Ottawa elementary school children of two socio-economic strata", *Hum. Biol.*, **19**, 68-82.
 1106. HUBBS, C. L. & PERLMUTTER, A. (1942), "Biometric comparison of several samples, with particular reference to racial investigations", *Amer. Nat.*, **76**, 582-92.
 1107. ITO, P. K. (1942), "Comparative biometrical study of physique of Japanese women born and reared under different environments", *Hum. Biol.*, **14**, 279-351.
 1108. JENSS, R. M. (1945), "Statistical methods in anthropometric studies in the field of nutritional research", *Amer. J. Publ. Hlth.*, **35**, 1053-6.
 1109. KAVANAGH, A. J. & RICHARDS, O. W. (1942), "Mathematical analysis of the relative growth of organisms", *Proc. Rochester Acad. Sci.*, **8**, 150-74.
 1110. LATIMER, H. B. (1947), "Correlations of organ weights with body weight, body length and with other weights in the adult cat", *Growth*, **11**, 61-75.
 1111. LUMER, H. & SCHULTZ, A. H. (1947), "Relative growth of the limb segments and tail in *Ateles geoffroyi* and *Cebus capucinus*", *Hum. Biol.*, **19**, 53-67.
 1112. MCKITTRICK, D. S. (1947), "The selection of chicks for growth experiments and the evaluation of growth", *Growth*, **11**, 89-99.
 1113. MANUILA, A. (1945), "Contributions aux études séro-anthropologique. I. Quel est le nombre nécessaire et suffisant d'examen dans les recherches biologiques?", *Arch. suisses Anthropol. gén. Suppl.*, **11**, 1-46.
 1114. MEDAWAR, P. B. (1944), "The shape of the human being as a function of time", *Proc. Roy. Soc., Ser. B*, **132**, 133-41.
 1115. MOORE, T. V. & HSU, E. H. (1946), "Factorial analysis of anthropological measurements in psychotic patients", *Hum. Biol.*, **18**, 133-57.
 1116. MORALES, M. F. & KREUTZER, A. S. F. L. (1945), "Some nutritional and excretional interactions and the growth of an organ or colony", *Bull. Math. Biophys.*, **7**, 15-24.
 1117. MUHSAM, H. V. (1947), "Correlation in growth", *Hum. Biol.*, **19**, 260-9.
 1118. NICHOLSON, C. (1943), "The probability integral for two variables", *Biometrika*, **33**, 59-72.
 1119. ROBINOW, M. T., RICHARDS, W. & ANDERSON, M. (1942), "The eruption of deciduous teeth", *Growth*, **6**, 127-33.
 1120. TELANG, D. M. & BHAGWAT (1941), "Studies in the vital capacity of Bombay medical students. Part I. Statistical correlation with physical measurements", *Indian J. Med. Res.*, **29**, 723-50.

1121. THURSTONE, L. L. (1947), "Factorial analysis of body measurements", *Amer. J. Phys. Anthropol.*, **5**, 15-28.
1122. WOLFORD, L. A. (1946), "A new graphic method of describing the growth of animals", *Biol. Bull.*, **90**, 141-7.
1123. WEIL, C. S. (1947), "Statistical evaluation of growth curves", *Proc. Soc. Exp. Biol.*, **64**, 468-70.

1.4. Biological Assay and Potency Estimation

1124. BACHARACH, A. L. & CHANCE, M. R. A. (1945), "Inter-litter variability as a source of error in gonadotrophin assay", *Quart. J. Pharm.*, **18**, 10-4.
1125. BARTLETT, M. S. (1946), "A modified probit technique for small probabilities", *J. R. Statist. Soc. Suppl.*, **8**, 113-7.
1126. DE BEER, E. J. (1945), "The calculation of biological assay results by graphic methods. The all-or-none type of response", *J. Pharmacol.*, **85**, 1-13.
1127. DE BEER, E. J. & SHERWOOD, M. B. (1945), "The paper-disc agar-plate method for the assay of antibiotic substances", *J. Bact.*, **50**, 459-67.
1128. BERKSON, J. (1944), "Application of the logistic function to bio-assay", *J. Amer. Statist. Ass.*, **39**, 357-65.
1129. BERKSON, J. (1946), "Approximation of Chi-square by 'probits' and by 'logits'", *J. Amer. Statist. Ass.*, **41**, 70-4.
1130. BITANCOURT, A. A. (1945), "A probit scale for slide rules", *Biometrics Bull.*, **1**, 46.
1131. BLISS, C. I. (1944), "The U.S.P. collaborative cat assays for digitalis", *J. Amer. Pharm. Ass.*, **33**, 225-45.
1132. BLISS, C. I. (1944), "A simplified calculation of the potency of penicillin and other drugs assayed biologically with a graded response", *J. Amer. Statist. Ass.*, **39**, 479-87.
1133. BLISS, C. I. (1945), "Confidence limits for biological assays", *Biometrics Bull.*, **1**, 57-65.
1134. BLISS, C. I. (1946), "An experimental design for slope-ratio assays", *Ann. Math. Statist.*, **17**, 232-7.
1135. BLISS, C. I. (1946), "A revised cylinder-plate assay for penicillin", *J. Amer. Pharm. Ass.*, **35**, 6-12.
1136. BLISS, C. I. & ALLMARK, M. G. (1944), "The digitalis cat assay in relation to rate of injection", *J. Pharmacol.*, **81**, 378-89.
1137. BLISS, C. I. & CATTELL, M. (1943), "Biological assay", *Ann. Rev. Physiol.*, **5**, 479-539.
1138. BOX, G. E. P. & COLLUMBINE, H. (1947), "The relationship between survival time and dosage with certain toxic agents", *Brit. J. Pharmacol. Chemotherap.*, **2**, 27-37.
1139. CHURCHMAN, C. W. & EPSTEIN, B. (1946), "Tests of increased severity", *J. Amer. Statist. Ass.*, **41**, 567-90.
1140. CAMPBELL, J. A., MIGICOVSKY, B. B. & EMSLIE, A. R. G. (1945), "Studies on the chick assay for vitamin D. I. Precision of tibia and toe ash as criteria of response", *Poult. Sci.*, **24**, 3-7.
1141. CAMPBELL, J. A., MIGICOVSKY, B. B. & EMSLIE, A. R. G. (1945), "Studies on the chick assay for vitamin D. II. A comparison of four criteria of calcification", *Poult. Sci.*, **24**, 72-80.
1142. CAMPBELL, J. A. & EMSLIE, A. R. G. (1945), "Studies on the chick assay for vitamin D. III. The variability of chicks and the estimation of error from replicated group data. IV. The reproducibility of five criteria of calcification", *Poult. Sci.*, **24**, 296-304.
1143. CAMPBELL, J. A. & EMSLIE, A. R. G. (1947), "Studies on the chick assay for vitamin D. V. A comparison of A.O.A.C. and B.S.I. diets and feeding periods", *Poult. Sci.*, **26**, 255-61.
1144. CAMPBELL, J. A. & EMSLIE, A. R. G. (1947), "Studies on the chick assay for vitamin D. VI. Sources of variation in the response of replicate groups with time", *Poult. Sci.*, **26**, 568-72.
1145. CURTIS, J. M., UMBERGER, E. J. & KNUDSEN, L. F. (1947), "The interpretation of estrogenic assays", *Endocrinology*, **40**, 831-40.
1146. DIMOND, A. E., HORSFALL, J. G., HEUBERGER, J. W. & STODDARD, E. M. (1941), "Role of the dosage-response curve in the evaluation of fungicides", *Conn. Agric. Exp. Stat. Bull.*, **451**.
1147. DORFMAN, R. I. & RUBIN, B. L. (1947), "Studies on the bio-assay of hormones: The assay of chorionic gonadotrophin from human pregnancy urine and serum", *Endocrinology*, **41**, 456-63.
1148. DUFRENOY, J. & GOYAN, F. M. (1947), "A graphical calculator for statistical analysis", *J. Amer. Pharm. Ass.*, **36**, 309-14.
1149. EMMENS, C. W. (1940), "The dose response relation for certain principles of the pituitary gland, and of the serum and urine of pregnancy", *J. Endocrinol.*, **2**, 194-225.
1150. EPSTEIN, B. & CHURCHMAN, C. W. (1944), "On the statistics of sensitivity data", *Ann. Math. Statist.*, **15**, 90-6.
1151. FIELLER, E. C. (1944), "A fundamental formula in the statistics of biological assay, and some applications", *Quart. J. Pharm.*, **17**, 117-23.
1152. FIELLER, E. C. (1947), "Some remarks on the statistical background in bio-assay", *Analyst*, **72**, 37-43.
1153. FINNEY, D. J. (1942), "Examples of the planning and interpretation of toxicity tests involving more than one factor", *Ann. Appl. Biol.*, **29**, 330-2.
1154. FINNEY, D. J. (1943), "The statistical treatment of toxicological data relating to more than one dosage factor", *Ann. Appl. Biol.*, **30**, 71-9.
1155. FINNEY, D. J. (1944), "Mathematics of biological assay", *Nature, Lond.*, **153**, 284.
1156. FINNEY, D. J. (1944), "The application of the probit method to toxicity test data adjusted for mortality in the controls", *Ann. Appl. Biol.*, **31**, 68-74.
1157. FINNEY, D. J. (1945), "The microbiological assay of vitamins: The estimate and its precision", *Quart. J. Pharm.*, **18**, 77-82.

1951]

1158. FINNEY, D. J. (1946), "The analysis of a factorial series of insecticide tests", *Ann. Appl. Biol.*, 33, 160-5.
1159. FINNEY, D. J. (1947), "The principles of biological assay", *J. R. Statist. Soc. Suppl.*, 9, 46-81.
1160. FINNEY, D. J. (1947), "The adjustment of biological assay results for variation in concomitant observations", *J. Hyg., Camb.*, 45, 397-406.
1161. FINNEY, D. J. (1947), "The estimation from individual records of the relationship between dose and quantal response", *Biometrika*, 34, 320-34.
1162. GADDUM, J. H. (1943), "The design of toxicity tests involving comparison with a standard preparation", *Quart. J. Pharm.*, 16, 78-86.
1163. GOYAN, F. M. & DUFRENOY, J. (1947), "A graphical calculator for bio-assays", *J. Amer. Pharm. Ass.*, 36, 305-8.
1164. GRIDGEMAN, N. T. (1943), "The technique of the biological vitamin A assay", *Biochem. J.*, 37, 127-32.
1165. GRIDGEMAN, N. T. (1944), "The estimation of vitamin A", *Lever Bros. and Unilever Ltd.*
1166. GRIDGEMAN, N. T. (1944), "Mathematics of biological assay", *Nature, Lond.*, 153, 461-62.
1167. GRIDGEMAN, N. T. (1945), "Special designs for vitamin D assays", *Quart. J. Pharm.*, 18, 15-23.
1168. GRIDGEMAN, N. T. (1945), "The potencies of vitamin D₂ and D₃", *Quart. J. Pharm.*, 18, 24-9.
1169. GRIDGEMAN, N. T. (1946), "The transformation of biological responses with special reference to vitamin D assays", *Analyst*, 71, 376-9.
1170. HALEY, T. J. (1947), "An instrument for plotting ED₅₀ curves", *Science*, 106, 151.
1171. HEDÉN, C.-G. (1946), "On the estimation of fifty per cent. end-points in serological titrimetry", *J. Path. Bact.*, 58, 477-81.
1172. HEWLETT, P. S. (1947), "A direct spray technique for the biological evaluation of pyrethrum-in-oil insecticides for use against stored product insects in warehouses", *Ann. Appl. Biol.*, 34, 357-75.
1173. HOLIDAY, E. R., IRWIN, J. O., *et al.* (1946), "The assay of crystalline preparations of ancurine by means of the ultra-violet absorption spectrum", *Quart. J. Pharm.*, 19, 155-72.
1174. HOLCK, H. G. O., KIMURA, K. K. & BARTELS, B. (1946), "Effect of the anaesthetic and the rate of injection of digitalis upon its lethal dose in cats", *J. Amer. Pharm. Ass.*, 35, 366-70.
1175. HORSFALL, F. L. & CURNEN, E. C. (1946), "Studies on pneumonia virus of mice (PVM). I. The precision of measurements *in vivo* of the virus and antibodies against it", *J. Exp. Med.*, 83, 25-42.
1176. IPSEN, J. (1942), "Systematische und zufällige Fehlerquellen bei Messung kleiner Antitoxinmengen", *Z. Immunforsch.*, 102, 347-368.
1177. IPSEN, J. & JERNE, N. K. (1944), "Graphical evaluation of the distribution of small experimental series", *Acta path. microbiol. scand.*, 21, 343-61.
1178. IRWIN, J. O. (1943), "The error of the biological assay of insulin by the mouse-convulsion test", *Quart. J. Pharm.*, 16, 352-62.
1179. IRWIN, J. O. (1943), "On the calculation of the error of biological assays", *J. Hyg., Camb.*, 43, 121-8.
1180. IRWIN, J. O. (1944), "A statistical examination of the accuracy of vitamin A assays", *J. Hyg., Camb.*, 43, 291-314.
1181. IRWIN, J. O. & GOODMAN, N. (1946), "The statistical treatment of measurements of the carcinogenic properties of tars and mineral oils", *J. Hyg., Camb.*, 44, 362-420.
1182. JONES, J. I. M. (1945), "The biological estimation of vitamin D", *Quart. J. Pharm.*, 18, 92-108.
1183. DE JONGH, S. E., LENS, S. & SPANHOFF, R. W. (1947), "On the standardization of insulin by means of the rabbit test", *Arch. int. Pharmacodyn.*, 74, 63-82.
1184. KENT, J. F., BUKANTZ, S. C. & REIN, C. R. (1946), "Studies in complement fixation. I. Spectrophotometric titration of complement; construction of graphs for direct determination of the 50% hemolytic unit", *J. Immunol.*, 53, 37-50.
1185. KNUDSEN, L. F. (1945), "The use of statistics in biological experimentation and assay", *J. Ass. Off. Agric. Chem., Wash.*, 28, 806-13.
1186. KNUDSEN, L. F. (1945), "Penicillin assay", *Science*, 101, 46-8.
1187. KNUDSEN, L. F. & CURTIS, J. M. (1947), "The use of the angular transformation in biological assays", *J. Amer. Statist. Ass.*, 42, 282-96.
1188. KNUDSEN, L. F. & RANDALL, W. A. (1945), "Penicillin assay and its control chart analysis", *J. Bact.*, 50, 187-200.
1189. KNUDSEN, L. F., SMITH, R. B., VOS, B. J. & McCLOSKEY, W. T. (1946), "The biological assay of epinephrine", *J. Pharmacol.*, 86, 339-43.
1190. LACEY, A. H. (1946), "Further observations on the rabbit method of insulin assay", *Endocrinology*, 39, 344-57.
1191. LANDAUER, W. & BLISS, C. I. (1946), "Insulin-induced rumplessness of chickens. III. The relationship of dosage and of developmental stage at time of injection to response", *J. Exp. Zool.*, 102, 1-22.
1192. LEA, D. E. (1945), "The biological assay of carcinogens", *Cancer Res.*, 5, 633-40.
1193. LOEWY, S. (1947), "Bio-assay by direct potency estimation", *Science*, 106, 89-91.
1194. MATHER, K. (1946), "The genetical requirements of bio-assays with higher organisms", *Analyst*, 71, 407-11.
1195. MCCALLAN, S. E. A. & WELLMAN, R. H. (1943), "Cumulative error terms for comparing fungicides by established laboratory and greenhouse methods", *Contr. Boyce Thompson Inst.*, 13, 135-41.
1196. MCCALLAN, S. E. A., WELLMAN, R. H. & WILCOXON, F. (1941), "An analysis of factors causing variations in spore germination tests of fungicides. III. Slope of toxicity curves, replicate tests and fungi", *Contr. Boyce Thompson Inst.*, 12, 49-78.

1197. MARTIN, H. (1943), "The evaluation of fungicides: A study of quantitative toxicology", *J. Soc. Chem. Ind. Trans.*, **62**, 67-71, 112.
1198. MILLER, L. C. & TAINTER, M. L. (1944), "Estimation of the ED_{50} and its error by means of logarithmic-probit graph paper", *Proc. Soc. Exp. Biol.*, **57**, 261-64.
1199. MOORE, W. & BLISS, C. I. (1942), "A method for determining insecticidal effectiveness using *Aphis rumicis* and certain organic compounds", *J. Econ. Ent.*, **35**, 544-53.
1200. MOSELEY, J. F., "A scheme for recording the potency of carcinogenic agents", *Cancer Res. Lab.*, **20** pp.
1201. NASS, C. A. G. (1947), "Het quantitative verband tussen dosering en letaliteit bij proefdieren", *Statistica*, **1**, 257-66.
1202. PARKER-RHODES, A. F. (1942), "Studies in the mechanism of fungicidal action. II. Elements of the theory of variability", *Ann. Appl. Biol.*, **29**, 126-35.
1203. PARKIN, E. A. & GREEN, A. A. (1943), "A film technique for the biological evaluation of pyrethrum-in-oil insecticides for use against stored product insects in warehouses", *Ann. Appl. Biol.*, **30**, 279-92.
1204. PONTECORVO, G. (1946), "The genetical aspects of bio-assays with micro-organisms", *Analyst*, **71**, 411-3.
1205. PRICE, W. C. (1946), "Measurement of virus activity in plants", *Biometrics Bull.*, **2**, 81-6.
1206. PRICE, W. C. & SPENCER, E. L. (1943), "Accuracy of the local-lesion method for measuring virus activity. III. The standard deviation of the log ratio of potencies as a measure of the accuracy of measurement", *Amer. J. Bot.*, **30**, 720-35.
1207. PUGSLEY, L. I. (1946), "The application of the principles of statistical analysis to the biological assay of hormones", *Endocrinology*, **39**, 161-76.
1208. SHERWOOD, M. B. (1947), "Simple formulas calculating percentage potency in three- and four-dose assay procedures", *Science*, **106**, 152-3.
1209. SHOCK, N. W. & SEBRELL, W. H. (1946), "The effect of different concentrations of pyridoxine hydrochloride on the work output of perfused frog muscles", *Amer. J. Physiol.*, **146**, 399-402.
1210. SHRIMPTON, E. A. G. (1943), "The biological assay of crystalline vitamin B_1 , aneurine hydrochloride, by the rat growth method", *Quart. J. Pharm.*, **16**, 86-101.
1211. SMITH, K. W., MARKS, H. P., FIELLER, E. C. & BROOM, W. A. (1944), "An extended cross-over design and its use in insulin assay", *Quart. J. Pharm.*, **17**, 108-17.
1212. SPICER, C. C. (1947), "The estimation of tumour susceptibility in pure lines", *Brit. J. Cancer*, **1**, 298.
1213. STANSLY, P. G. & SCHLOSSER, M. E. (1947), "Studies in polymyxin: An agar diffusion method of assay", *J. Bact.*, **54**, 585-97.
1214. STARR, D. F. (1944), "The theory of probits at high mortalities", *J. Econ. Ent.*, **37**, 850.
1215. SWYER, G. I. M. & EMMENS, C. W. (1947), "A modified method for the viscosimetric assay of hyaluronidase", *Bio-Chem. J.*, **41**, 29-34.
1216. THOMPSON, W. R. (1947), "Use of moving averages and interpolation to estimate median-effective dose. I. Fundamental formulas, estimation of error, and relation to other methods", *Bact. Rev.*, **11**, 115-45.
1217. THOMPSON, W. R. and MALTANER, F. (1940), "On the construction of graphs and tables for evaluation of the quantitative complement-fixation reactions and reaction ratios", *J. Immunol.*, **38**, 147-57.
1218. WADDELL, J. & KENNEDY, G. H. (1947), "The antirachitic potency of pure crystalline vitamin D_3 in comparison with the U.S.P. reference cod liver oil when assayed by the chick method", *J. Ass. Off. Agric. Chem., Wash.*, **30**, 190-206.
1219. WHITLOCK, J. H. (1943), "Characteristics of the population available for bio-assay of anthelmintics in *Nippostrongylus muris* infection in albino rats", *J. Parasit.*, **29**, 42-7.
1220. WHITLOCK, J. H. & BLISS, C. I. (1943), "A bio-assay technique for anthelmintics", *J. Parasit.*, **29**, 48-58.
1221. WIEN, R. & PHILLIPS, G. E. (1945), "The control of mercurochrome by toxicity tests", *Quart. J. Pharm.*, **18**, 35-40.
1222. WILD, A. M. (1947), "General equation for the serial dilution technique in microbiological assays", *Nature, Lond.*, **160**, 57-8.
1223. WILSON, E. B. & WORCESTER, J. (1943), "The determination of L.D. 50 and its sampling error in bio-assay", *Proc. Nat. Acad. Sci.*, **29**, 79-85, 114-20, 257-62.
1224. WILSON, E. B. & WORCESTER, J. (1943), "Bio-assay on a general curve," *Proc. Nat. Acad. Sci.*, **29**, 150-4.
1225. WINDER, C. V. (1947), "Misuse of 'deduced ratios' in the estimation of median effective doses", *Nature, Lond.*, **159**, 883.
1226. WOOD, E. C. (1944), "Mathematics of biological assay", *Nature, Lond.*, **153**, 84-5, 680-1.
1227. WOOD, E. C. (1946), "Computation of biological assays", *Nature, Lond.*, **158**, 835.
1228. WOOD, E. C. (1945), "Calculation of the results of microbiological assays", *Nature, Lond.*, **155**, 632.
1229. WOOD, E. C. (1946), "The theory of certain analytical procedures, with particular reference to microbiological assays", *Analyst*, **71**, 1-14.
1230. WOOD, E. C. (1947), "The computation of microbiological assays of amino-acids and other growth factors", *Analyst*, **72**, 84-90.
1231. WOOD, E. C. (1947), "Short cuts to the estimation of standard errors, particularly in microbiological assays", *Chem. Ind. Rev.*, **66**, 334-6.
1232. WOOD, E. C. & FINNEY, D. J. (1946), "The design and statistical analysis of microbiological assays", *Quart. J. Pharm.*, **19**, 112-27.

1951]

1233. WORCESTER, J. & WILSON, E. B. (1943), "A table determining L.D. 50 or the fifty per cent. end-point", *Proc. Nat. Acad. Sci.*, **29**, 207-12.

1.5. Medical Statistics and Epidemiology

1234. ARNOLD, E. H. (1944), "Médecine et statistique", *J. Méd. Leysin*, **22**, 393-400.
1235. BARKWORTH, H. & IRWIN, J. O. (1943), "Comparative detection of coliform organisms in milk and water by the presumptive coliform test, with an appendix on the possible bactericidal effect of bile salt", *J. Hyg., Camb.*, **43**, 129-35.
1236. BEARD, R. E. (1947), "The standard deviation of the distribution of sickness", *J. Inst. Actu. Stud. Soc.*, **7**, 23-8.
1237. BECKS, H. & WAINWRIGHT, W. W. (1946), "Human saliva. XVI. Relationship of total calcium to inorganic phosphorus of resting saliva. XVII. Relationship of total calcium and inorganic phosphorus to rate of flow of resting saliva", *J. Dent. Res.*, **25**, 267-83.
1238. BERG, W. N. (1945), "Blood cell counts. Their statistical interpretation", *Amer. Rev. Tuberc.*, **52**, 179-220.
1239. BENKSON, J. (1946), "Limitations of the applications of fourfold table analysis to hospital data", *Biometrics Bull.*, **2**, 47-53.
1240. BERTRAND, I. & QUIVY, D. (1945), "Distribution statistique de coefficient exponentiel a de Fischer", *C. R. Soc. Biol. Paris*, **139**, 603-5.
1241. BLUM, H. F. (1943), "Accuracy and reproducibility in the induction of tumours with ultra-violet radiation", *J. Nat. Cancer Inst.*, **4**, 75-9.
1242. BROWNING, W. H. (1943), "Mold fungi in the etiology of respiratory allergic diseases. II. Mold extracts—a statistical study", *J. Allergy*, **14**, 231-43.
1243. BUCHER, O., DEBRUNNER, H. & STÄDELI, H. (1947), "Die Wirkung von Penicillin auf menschliche Leukocyten *in vitro*, zugleich ein Beitrag zur statistischen Auswertung biologischer Untersuchungsergebnisse", *Schweiz. med. Wschr.*, **77**, 332-5.
1244. CARLINFANTI, E. & CAVALLI, L. e. L. (1945), "Studi quantitativi sull'immunità", *Boll. Ist. sieroter. Milano*, **24**, 215-32.
1245. CHEVALLIER, A. (1946), "L'application de la méthode statistique aux données médicales", *Sem. Hôp. Paris*, **22**, 1756-7.
1246. CRUICKSHANK, D. B. (1947), "Regional influences in cancer", *Brit. J. Cancer*, **1**, 109-28.
1247. DENSEN, P. M. (1947), "The development and use of statistical practices in hospital work", *Biometrics*, **3**, 109-18.
1248. DIVISIA, F. (1943), "Essai de théorie statistique de la contagion et de la contamination donnant un critère de classification des maladies microbiennes au point de vue social et au point de vue individuel et, éventuellement, quelques directives pour l'étude scientifique de ces maladies", *Rev. Inst. int. Statist.*, **11**, 150-69.
1249. ELSDON-DEW, R. (1947), "Statistical errors in counting blood cells", *Amer. J. Clin. Path.*, **17**, 575-9.
1250. GHOSH, M. N. & ROY, S. N. (1946), "On a statistical test of treatment effect on certain diseases", *Sankhyā*, **8**, 195-6.
1251. GREENWOOD, M. (1943), "Medical statistics from Graunt to Farr. VI. Some English medical statisticians in the eighteenth century", *Biometrika*, **33**, 1-24.
1252. GREENWOOD, M. (1946), "The statistical study of infectious diseases", *J. R. Statist. Soc.*, **109**, 85-103.
1253. HAMMOND, W. H. (1944), "Factor analysis as an aid to nutritional assessment", *J. Hyg., Camb.*, **43**, 395-9.
1254. HEIBERG, P. & PETERSEN, H. (1946), "The epidemic curve for mumps", *J. Hyg., Camb.*, **44**, 350-1.
1255. HENDERSON, C. R. & RILEY, E. C. (1945), "Certain statistical considerations in patch testing", *J. Invest. Dermat.*, **6**, 227-30.
1256. HIATT, C. W. (1947), "Certain mathematical aspects of the susceptibility of erythrocytes to lysis", *Proc. Soc. Exp. Biol.*, **66**, 279-81.
1257. HILL, A. B. (1947), "Statistics in medicine", *Trans. Manch. Statist. Soc.*, **1946-1947**, 1-15.
1258. HILL, A. B. (1947), "Statistics in the medical curriculum?", *Brit. Med. J.*, **2**, 366-8.
1259. HILL, H. W. (1944), "Speed of reaction hypothesis. I. Its numerical foundation in respect to the tubercle bacillus", *Amer. Rev. Tuberc.*, **49**, 414-22.
1260. HILL, H. W. (1946), "Speed of reaction hypothesis. II. Further numerical implications regarding tuberculosis", *Amer. Rev. Tuberc.*, **53**, 1-33.
1261. HITT, H. L. (1947), "The use of selected cartographic techniques in health research", *Social Forces*, **26**, 189-96.
1262. IRWIN, J. O. & GOODMAN, N. (1946), "The statistical treatment of measurements of the carcinogenic properties of tars and mineral oils", *J. Hyg., Camb.*, **44**, 362-420.
1263. JARCHO, S. (1945), "Equal-area projections and the azimuthal equidistant projection in maps of disease", *Amer. J. Publ. Hlth.*, **35**, 1005-13.
1264. JELLINEK, E. M. (1946), "Clinical tests on comparative effectiveness of analgesic drugs", *Biometrics Bull.*, **2**, 87-91.
1265. JORDAN, R. C. & JACOBS, S. E. (1944), "Studies in the dynamics of disinfection. I. New data on the reaction between phenol and *Bact. coli* using an improved technique, together with an analysis of the distribution of resistance amongst the cells of the bacterial populations studied", *J. Hyg., Camb.*, **43**, 275-89.

1266. JORDAN, R. C. & JACOBS, S. E. (1944), "Studies in the dynamics of disinfection. II. The calculation of the concentration exponent for phenol at 35° C. with *Bact. coli* as test organism", *J. Hyg., Camb.*, **43**, 363-9.
1267. JORDAN, R. C. & JACOBS, S. E. (1945), "Studies in the dynamics of disinfection. III. The reaction between phenol and *Bact. coli*: the effect of temperature and concentration: with a detailed analysis of the reaction velocity", *J. Hyg., Camb.*, **44**, 210-20.
1268. JORDAN, R. C. & JACOBS, S. E. (1945), "Studies in the dynamics of disinfection. IV. The reaction between phenol and *Bact. coli*: the true shape of the probit-log survival-time curve", *Ann. Appl. Biol.*, **32**, 221-9.
1269. JORDAN, R. C. & JACOBS, S. E. (1946), "Studies in the dynamics of disinfection. V. The temperature coefficient of the reaction between phenol and *Bact. coli*, derived from data obtained by an improved technique. VI. Calculation of a new and constant temperature coefficient for the reaction between phenol and *Bact. coli*", *J. Hyg., Camb.*, **44**, 243-55.
1270. JORDAN, R. C. & JACOBS, S. E. (1946), "Studies in the dynamics of disinfection. VII. The reaction between phenol and *Bact. coli*: the effect of temperature on the usually accepted concentration exponent and the calculation of a more satisfactory exponent based on theoretical considerations", *J. Hyg., Camb.*, **44**, 421-9.
1271. JORDAN, R. C., JACOBS, S. E. & DAVIES, H. E. F. (1947), "Studies in the dynamics of disinfection. VIII-IX. The effect of lethal temperatures on standard cultures of *Bact. coli*. I. A detailed analysis of the variations of death-rate with time. II. The nature of the probit-log survival-time relation-ship at pH 7.0", *J. Hyg., Camb.*, **45**, 136-48.
1272. JORDAN, R. C., JACOBS, S. E. & DAVIES, H. E. F. (1947), "Studies in the dynamics of disinfection. X-XI. The effect of lethal temperatures on standard cultures of *Bact. coli*. III. On the variation of the rate of disinfection with temperature at pH 7.0, including the calculation of a new and constant temperature coefficient. IV. An investigation of that portion of the population which survives prolonged exposure at pH 7.0", *J. Hyg., Camb.*, **45**, 333-53.
1273. KALMUS, H. (1947), "The incidence of placenta praevia and antepartum haemorrhage according to maternal age and parity. With a note on the mathematical treatment by Cedric A. B. Smith", *Ann. Eugen., Lond.*, **13**, 283-90.
1274. KARN, M. N. (1947), "Length of human gestation with special reference to prematurity", *Ann. Eugen., Lond.*, **14**, 44-59.
1275. KNUDSEN, L. F. (1945), "Note on statistical probabilities of finding hypersensitive subjects in random samples", *J. Invest. Dermat.*, **6**, 231-2.
1276. LIDWELL, O. M. (1946), "Bactericidal effects of the partial irradiation of a room with ultra-violet light", *J. Hyg., Camb.*, **44**, 333-41.
1277. LOMBARD, H. L. & DOERING, C. R. (1947), "Treatment of the fourfold table by partial association and partial correlation as it relates to public health problems", *Biometrics*, **3**, 123-8.
1278. LUYKX, H. M. C. (1944), "Biostatistics in medical research. I. Significant differences", *Nav. Med. Bull. Wash.*, **43**, 1208-15.
1279. LUYKX, H. M. C. (1945), "Biostatistics in medical research. II. Probabilities in small samples", *Nav. Med. Bull. Wash.*, **44**, 125-33.
1280. LUYKX, H. M. C. (1945), "Biostatistics in medical research. III. Samples which are 100 per cent. positive", *Nav. Med. Bull. Wash.*, **44**, 370-4.
1281. MARTINEZ-FORTUN, O. (1946), "Importancia de la estadística en epidemiología", *Rev. Med. Cirug. Habana*, **51**, 228-42.
1282. MATHER, K., BOWLER, R. G., CROOKE, A. C. & MORRIS, C. J. O. R. (1947), "The precision of plasma volume determinations by the Evans Blue method", *Brit. J. Exp. Path.*, **28**, 12-24.
1283. MEYER, S. N. (1946), "Some theoretical views on the shape of the tubercular infection curve and its dependence on infection risk", *Skand. Aktuar. Tidskr.*, **29**, 1-11.
1284. MEYER, S. N. (1947), "Statistic problems regarding tuberculosis infection and morbidity of tuberculosis", *Skand. Aktuar. Tidskr.*, **30**, 130-50.
1285. MICKELSEN, O., CASTER, W. O. & KEYS, A. (1947), "A statistical evaluation of the thiamine and pyrimin excretions of normal young men on controlled intakes of thiamine", *J. Biol. Chem.*, **168**, 415-31.
1286. MILES, A. A. (1946), "The frequencies of bacterial subtypes in a carrier community and their significance", *J. Path. Bact.*, **58**, 269-73.
1287. MINER, J. R. (1945), "Some uses of statistical methods in medicine", *Biometrics Bull.*, **1**, 3-5.
1288. MRUGOWSKY, J. (1941), "Die Analyse von Seuchenkurven", *Z. Hyg. InfektKr.*, **123**, 361-73.
1289. MUENCH, H. (1947), "Statistics in the planning and evaluation of health practices", *Amer. J. Publ. Hlth.*, **37**, 1273-6.
1290. NEYMAN, J. (1947), "Outline of statistical treatment of problem of diagnosis", *Publ. Hlth. Rep.*, **62**, 1449-56.
1291. NOLFI, P. (1945), "Zur mathematischen Darstellung wachsender Gesamtheiten", *Mitt. Ver. schweiz. Versich. Math.*, **45**, 311-21.
1292. PHAIR, J. J., SCHOENBACH, E. B. & MERRELL, M. (1946), "Chemoprophylaxis in the prevention of disease with especial reference to meningococcal infections. I. A comparative study of the absorption, persistence and excretion of four sulfonamide compounds", *Hum. Biol.*, **18**, 171-203.
1293. RHODES, F. (1946), "Percentage table for the estimation of sickness rates for special periods of sickness", *J. Inst. Actu.*, **72**, 455-69.

1951]

1294. RICH, W. H. & TERRY, M. C. (1946), "Industrial 'control chart' applied to study of epidemics", *Publ. Hlth. Rep.*, **61**, 1501-11.
1295. DE RUDDER, B. (1943), "Allgemeinbiologisches zur Phänogenese statistischer Krankheitsgipfel", *Klin. Wschr.*, **22**, 453-7.
1296. RUSSEL, C. S. (1945), "Errors in the routine daily measurement of the puerperal uterus", *Biometrika*, **33**, 213-21.
1297. SAWITZ, W. G. & HAMMERSTROM, R. J. (1943), "The statistical significance of a negative stool examination in the diagnosis of amebiasis", *Amer. J. Hyg.*, **38**, 1-7.
1298. SCHILLING, W. (1944), "Analysis of the data of a public health organization by the control chart method", *J. Amer. Statist. Ass.*, **39**, 311-24.
1299. SCHLAMOWITZ, I. (1946), "An analysis of the time relationships within the cardiac cycle in electrocardiograms of normal men", *Amer. Heart J.*, **31**, 329-42, 464-76.
1300. SENEVET, G. (1942), "Quelques notions pratiques de statistique médicale", *Arch. Inst. Pasteur Algér.*, **20**, 172-97.
1301. SOLANDT, D. Y., DE LURY, D. B. & HUNTER, J. (1943), "Effect of electrical stimulation on atrophy of denervated muscle", *Arch. Neurol. Psychiat.*, *Chicago*, **49**, 802-7.
1302. TEORELL, T. (1946), "Quantitative aspects of antigen-antibody reactions. I. A theory and its corollaries. II. Some comparisons between the theory and the experimental results", *J. Hyg., Camb.*, **44**, 227-42.
1303. WAINWRIGHT, W. W. & BECKS, H. (1946), "Human saliva XVIII. Is there a seasonal influence on rate of flow and calcium and phosphorus content of resting saliva?", *J. Dent. Res.*, **25**, 285-91.
1304. WEISS, E. S. & KENDRICK, P. L. (1943), "The effectiveness of pertussis vaccine: An application of Sargent and Merrell's method of measurement", *Amer. J. Hyg.*, **38**, 306-9.
1305. WILKINS, J. E. (1945), "The difference equation for epidemics", *Bull. Math. Biophys.*, **7**, 149-50.
1306. WILSON, E. B. & BURKE, M. H. (1942), "The epidemic curve", *Proc. Nat. Acad. Sci., Wash.*, **28**, 361-7.
1307. WILSON, E. B. & WORCESTER, J. (1944), "A second approximation to Soper's epidemic curve", *Proc. Nat. Acad. Sci., Wash.*, **30**, 37-44.
1308. WILSON, E. B. & WORCESTER, J. (1944), "The epidemic curve with no accession of susceptibles", *Proc. Nat. Acad. Sci., Wash.*, **30**, 264-9.
1309. WILSON, E. B. & WORCESTER, J. (1944), "Note on stability of incidence of the 'common cold'", *Science*, **99**, 468-9.
1310. WILSON, E. B. & WORCESTER, J. (1945), "The law of mass action in epidemiology", *Proc. Nat. Acad. Sci., Wash.*, **31**, 24-34, 109-16.
1311. WILSON, E. B. & WORCESTER, J. (1945), "The variation of infectivity", *Proc. Nat. Acad. Sci., Wash.*, **31**, 142-7, 203-8.
1312. WILSON, E. B. & WORCESTER, J. (1945), "Damping of epidemic waves", *Proc. Nat. Acad. Sci., Wash.*, **31**, 294-8.
1313. WILSON, E. B. & WORCESTER, J. (1945), "The spread of an epidemic", *Proc. Nat. Acad. Sci., Wash.*, **31**, 327-33.
1314. WOJTA, H. (1941), "Wahrscheinlichkeitsmathematische Grundlagen der Erfolgsstatistik", *Dtsch. Z. Chir.*, **255**, 49-73.
1315. YERUSHALMY, J. (1947), "Statistical problems in assessing methods of medical diagnosis, with special reference to X-ray techniques", *Publ. Hlth. Rep.*, **62**, 1432-49.
1316. YOUNG, L. E. & MERRELL, M. (1943), "The mouse-adapted Lansing strain of poliomyelitis virus. II. A quantitative study of certain factors affecting the reliability of the neutralization test", *Amer. J. Hyg.*, **37**, 80-92.
1317. ZAPP, J. A. (1947), "Statistical approaches to some problems of industrial preventive medicine", *Hum. Biol.*, **19**, 27-52.
1318. ZIEZOLD, B. (1942), "Weitere Ergebnisse der Analyse von Seuchenkurven", *Z. Hyg. InfektKr.*, **124**, 93-114.
1319. ZIEZOLD, B. (1943), "Zur Seuchenvorhersage", *Z. Hyg. InfektKr.*, **124**, 704-29.

1.6. Miscellaneous

1320. ALMEIDA, A. (1942), "Estatística e biologia", *Rev. brasil. Estat.*, **3**, 65-76.
1321. ALPATOV, W. W. (1944), "A basic principle governing the changes in organisms under the action of external factors", *Nature, Lond.*, **154**, 54-5.
1322. BAAS BECKING, L. G. M. (1946), "On the analysis of sigmoid curves", *Acta biol.*, **8**, 42-59.
1323. BATEN, W. D. (1943), "The discriminant functions applied to spore measurements", *Mich. Acad. Sci.*, **29**, 3-7.
1324. BATEN, W. D. (1946), "Analysis of scores from smelling tests", *Biometrics Bull.*, **2**, 11-4.
1325. BATEN, W. D. (1945), "The use of discriminant functions in comparing judges' scores concerning potatoes", *J. Amer. Statist. Ass.*, **40**, 223-8.
1326. BATEN, W. D. & TROUT, G. M. (1946), "A critical study of the summation-of-difference-in-rank method of determining proficiency in judging dairy products", *Biometrics Bull.*, **2**, 67-9.
1327. BERRY, J. C. (1945), "Reliability of averages of different numbers of lactation records for comparing dairy cows", *J. Dairy Sci.*, **28**, 355-66.
1328. BIEHLER, W. & WOHLSCHNITT, H. (1941), "Beitrag zur statistischen Beurteilung biologischer Wirkungen", *Arch. Exp. Path. Pharmac.*, **198**, 278-91.

1329. BIRCH, L. C. (1944), "The effect of temperature and dryness on, the survival of the eggs of *Calandra oryzae* L. (small strain) and *Rhizopertha dominica* Fab. (Coleoptera)", *Aust. J. Exp. Biol. Med. Sci.*, **22**, 265-9.
1330. BIRCH, L. C. (1944), "Two strains of *Calandra oryzae* L. (Coleoptera)", *Aust. J. Exp. Biol. Med. Sci.*, **22**, 217-5.
1331. BIRCH, L. C. (1944), "An improved method for determining the influence of temperature on the rate of development of insect eggs (using eggs of the small strain of *Calandra oryzae* L. (Coleoptera))", *Aust. J. Exp. Biol. Med. Sci.*, **22**, 277-83.
1332. BLAXTER, K. L. (1948), "The evaluation of the nutritive value of animal feeding-stuffs; the application of statistical methods to food problems", *Analyst*, **73**, 11-5.
1333. BROUWER, E. (1946), "Sur des indices complexes pour le beurre", *Acta brev. neerl. Physiol.*, **13**, 74-7.
1334. BRUNI, L. (1947), "Generalità su un nuovo metodo statistico per lo studio dei problemi della nutrizione", *Giorn. Econ.*, **6**, 372-8.
1335. CAMACHO BANOS, I. (1946), "Sobre métodos estadísticos para la determinación del éxito en series de observaciones", *Rev. Sanid. Hig. publ., Madr.*, **20**, 818-31.
1336. CAVALLI, L. L. & MAGNI, G. (1947), "Methods of analysing the virulence of bacteria and viruses for genetical purposes", *Heredity*, **1**, 127-32.
1337. COCHRAN W. G. (1945), "Training at the professional level for statistical work in agriculture and biology", *J. Amer. Statist. Ass.*, **40**, 160-6.
1338. COCHRAN, W. G., CANNON, C. Y. & AUTREY, K. M. (1941), "A double change-over design for dairy cattle feeding experiments", *J. Dairy Sci.*, **24**, 937-51.
1339. COMSTOCK, R. E. & WINTERS, L. M. (1942), "Design of experimental comparisons between lines of breeding in livestock", *J. Agric. Res.*, **64**, 523-32.
1340. CRAMPTON, E. W. (1942), "The design of animal husbandry experiments", *J. Anim. Sci.*, **1**, 263-76.
1341. EISENHART, C. & WILSON, P. W. (1943), "Statistical methods and control in bacteriology", *Bact. Rev.*, **7**, 57-137.
1342. EMIK, L. O. (1947), "Statistical treatment of counts of trichostrongylid eggs", *Biometrics*, **3**, 89-93.
1343. FALCONER, D. S. (1947), "Sensory thresholds for solutions of phenyl-thio-carbamide. Results of tests on a large sample, made by R. A. Fisher", *Ann. Eugen., Lond.*, **13**, 211-22.
1344. FAURÉ-FREMIET, E. (1944), "Étude biométrique de quelques Trichodines", *Bull. Soc. zool. Fr.*, **68**, 158-69.
1345. FIERRO DEL RIO, L. (1943), "Calculo de la cifra media y de los valores limites normales du un grupo de mediciones biológicas", *Rev. Esc. Méd. Mil.*, **2**, 27-33.
1346. FINNEY, D. J. (1947), "Application of statistical methods to food problems", *Nature, Lond.*, **159**, 36-7.
1347. FLEISCH, A. & TRIPOD, J. (1942), "Die Berechnung von Mittelwerten in der Biologie", *Arch. exp. Path. Pharmacol.*, **200**, 135-45.
1348. DE FREITAS FILHO, L. (1942), "O clínico e a bioestatística. (Estudos e sugestões)", *Rev. brasil. Estat.*, **3**, 153-74.
1349. FRICK, G. E., MANN, A. I. & JOHNSON, S. (1947), "The relation of season of freshening to milk production", *J. Dairy Sci.*, **30**, 631-40.
1350. GAINES, W. L. DAVIS, H. P. & MORGAN, R. F. (1947), "Within-cow regression of milk-energy yield on age and live weight", *J. Dairy Sci.*, **30**, 273-8.
1351. GARRETT, H. E. (1943), "Mean differences and individual differences", *Hum. Biol.*, **15**, 166-70.
1352. GAÜMANN, E. (1943), "Über die Berechnung mittlerer Kurven", *Ber. dtsh. bot. Ges.*, **61**, 111-4.
1353. GOULDEN, C. H. (1944), "Experimental design for cereal chemists", *Cereal Chem.*, **21**, 159-71.
1354. GOULDEN, C. H. & PAULL, A. E. (1946), "Statistical methods in cereal chemistry", *Biometrics Bull.*, **2**, 26-30.
1355. GRANDSTAFF, J. O. & BLUNN, C. T. (1945), "Evaluating fleece quality of Navajo sheep from small samples", *J. Agric. Res.*, **71**, 183-92.
1356. GRAY, P. (1947), "The effect of the death rate in biological experiments on the validity of observations, and on the 'chi square' test for association", *Arch. Biochem.*, **13**, 461-74.
1357. GUYTON, A. C. (1947), "Analysis of respiratory patterns in laboratory animals", *Amer. J. Physiol.*, **150**, 78-83.
1358. HABS, H. (1942), "Herstellung geometrischer Reihen", *Klin. Wschr.*, **21**, 348.
1359. HANSEN, J. W. (1943), "Surface area of Persian walnuts", *J. Econ. Ent.*, **36**, 347.
1360. HARDIN, G. (1945), "A more meaningful form of the 'logistic' equation", *Amer. Nat.*, **79**, 279-81.
1361. HAUSCHILD, J. (1947), "Zur Beurteilung des Pflanzgutwertes von Saatkartoffelfeldern unter Berücksichtigung des Auftretens der Überträger der Kartoffelvirose. Versuch einer rechnerischen Lösung des Problems", *Züchter*, **17/18**, 241-7.
1362. HEADLEY, F. B. (1945), "Relation of production of dairy cows to the nutrients fed", *J. Anim. Sci.*, **4**, 369-72.
1363. HILL, T. L. & HILL, L. E. (1945), "Contribution to the theory of discrimination learning", *Bull. Math. Biophys.*, **7**, 107-14.
1364. HINTZSCHE, E. (1946), "Biologische Statistik durch materialgerechte Klasseneinteilung", *R. suisse Econ. Pol. Statist.*, **82**, 433-43.
1365. HOPKINS, J. W. (1946), "Precision of assessment of palatability of foodstuffs by laboratory panels", *Canad. J. Res. F.*, **24**, 203-14.
1366. HURTADO, A. (1945), "Métodos estadísticos", *An. Fac. Med., Lima*, **28**, 125-306.
1367. IPSEN, J. & JERNE, N. K. (1944), "Graphical evaluation of distribution of small experimental series", *Acta path. microbiol. scand.*, **21**, 343.

1951]

1368. KNUDSEN, L. F. (1944), "The value of statistics in the formulation of chemical methods", *J. Ass. Off. Agric. Chem.*, **27**, 145-53.
1369. KOYENUMA, N. (1943), "Beitrage zur Theorie der biologischen Strahlenwirkung", *Z. Phys.*, **120**, 185-211.
1370. LANDAHL, H. D., McCULLOCH, W. S. & PITTS, W. (1943), "A statistical consequence of the logical calculus of nervous nets", *Bull. Math. Biophys.*, **5**, 135-7.
1371. LESLIE, P. H., PERRY, J. S. & WATSON, J. S. (1945), "The determination of the median body-weight at which female rats reach maturity", *Proc. Zool. Soc. Lond.*, **115**, 473-88.
1372. LEVIN, M. L. & GOLDSTEIN, H. (1945), "Significance of negative results in small samples", *Science*, **102**, 407.
1373. LUDWIG, W. (1942), "Notiz zu der unternormalen Streuung in den Moewusschen Chlamydomonas-Versuchen", *Z. indukt. Abstamm.-u. Vererblehre*, **80**, 612-5.
1374. MARCUSE, S. (1947), "Applying control chart methods to tasting", *Food Industr.*, **19**, 316-8.
1375. MARCUSE, S. (1945), "An application of the control chart method to the testing and marketing of foods", *J. Amer. Statist. Ass.*, **40**, 214-22.
1376. MARZOLF, S. S. (1945), "Symptom and syndrome statistically interpreted", *Psychol. Bull.*, **42**, 162-76.
1377. MATHEW, N. T. (1943), "The lines on the human palm", *Sankhya*, **6**, 279-82.
1378. MILLER, L. P. (1946), "Particle size distribution in cocoa powders", *Contr. Boyce Thompson Inst.*, **14**, 325-34.
1379. MILLER, R. S. (1944), "An attempted simplification of the mathematical method of subspecific differentiation and identification", *Emu*, **43**, 253-8.
1380. MUENCH, H. (1945), "Experiments and the statistician", *Nutr. Rev.*, **3**, 321-2.
1381. OLBRYCHT, T. M. (1943), "The statistical basis of selection in animal husbandry: I. Studies on life performance of brood sows: An analysis of variance and covariance of progeny born and reared", *J. Agric. Sci.*, **33**, 28-43.
1382. OLBRYCHT, T. M. (1943), "The statistical basis of selection in animal husbandry: II. Studies on life performance of brood sows: The judging of brood sows by their number of offspring born and reared in the earliest litters", *J. Agric. Sci.*, **33**, 74-84.
1383. OPATOWSKI, I. (1946), "The probabilistic approach to the effects of radiations and variability of sensitivity", *Bull. Math. Biophys.*, **8**, 101-19.
1384. RASCH, G. (1947), "Recent biometric developments in Denmark", *Biometrics*, **3**, 172-5.
1385. RENDEL, J. M. (1943), "Variations in the weights of hatched and unhatched ducks' eggs. (With Appendices by J. B. S. Haldane.)", *Biometrika*, **33**, 48-58.
1386. RICKER, W. E. (1945), "Some applications of statistical methods to fishery problems", *Biometrics Bull.*, **1**, 73-9.
1387. SCHELLING, H. v. (1941), "Fehlerrechnung bei biologischen Messungen", *Klin. Wschr.*, **20**, 741-3.
1388. SIMPSON, G. G. (1947), "Note on the measurement of variability and on relative variability of teeth of fossil mammals", *Amer. J. Sci.*, **245**, 522-5.
1389. SIMPSON, G. G. (1945), "Notes on graphic biometric comparison of samples", *Amer. Nat.*, **79**, 95-6.
1390. SPIEGELMAN, S. (1946), "The constants in the 'logistic' equation", *Amer. Nat.*, **80**, 186-8.
1391. STEINER, E. H. (1948), "Application of statistical methods in calculating proportions of ingredients in certain food products; the application of statistical methods to food problems", *Analyst*, **73**, 15-29.
1392. TEISSIER, G. (1946), "Mathématiques et biologie", *Rev. gén. Sci. pur. appl.*, **53**, 92-9.
1393. TORRIE, J. H. & DICKSON, J. G. (1943), "The use of statistical methods in quality evaluation of barley and malt data", *Cereal Chem.*, **20**, 579-94.
1394. UPHOLT, W. M. (1945), "Observations on wartime biometrics", *Biometrics Bull.*, **1**, 47-52.
1395. WELLMAN, R. H. & MCCALLAN, S. E. A. (1943), "Correlation within and between laboratory slide-germination, greenhouse tomato foliage disease, and wheat smut methods of testing fungicides", *Contr. Boyce Thompson Inst.*, **13**, 143-69.
1396. WILCOXON, F. (1945), "Some uses of statistics in plant pathology", *Biometrics Bull.*, **1**, 41-5.
1397. WILCOXON, F. (1946), "Individual comparisons of grouped data by ranking methods", *J. Econ. Ent.*, **39**, 269-70.
1398. WINTERS, L. M. & GREEN, W. W. (1944), "A study of the predictive value of scores on body conformation of pigs taken previous to final score", *J. Anim. Sci.*, **3**, 399-405.
2. AGRICULTURE. EMILY P. POULTON
1399. AFZAL, M., NATH NANDA, D. & ABBAS, M. (1943), "Studies on the cotton jassid (*Empoasca devastans* Distant) in the Punjab. IV. A note on the statistical study of jassid population", *Indian J. Agric. Sci.*, **13**, 634-8.
1400. ALLEN, N. N. (1944), "A standard for evaluation of dairy sires proved in dairy herd improvement associations", *J. Dairy Sci.*, **27**, 835-47.
1401. ANDERSON, J. A. (1945), "The role of statistics in technical papers", *Trans. Amer. Ass. Cereal Chemists*, **3**, 69-73.
1402. ANDERSON, R. L. (1946), "Missing plot techniques", *Biometrics Bull.*, **2**, 41-7.
1403. ANDERSSON, E. (1943), "Plant breeding and forestry: A contribution to the discussion", *Skogen*, **30**, 178-80.
1404. ANDERSSON, E. & TEDIN, O. (1944), "The effect upon the mean and variability of the dependent variate of a selection according to the independent", *Hereditas, Lund.*, **30**, 249-53.

1405. ANÓS, A. (1944), "Present state of the theory of testing statistical hypotheses", *Bol. Inst. Invest. Exp. Agron. For., Madr.*, **10**, 93-135.
1406. ANÓS, A. (1945), "A graphical method for determining the number of replications necessary in comparative experiments", *Bol. Inst. Invest. Exp. Agron. For., Madr.*, **13**, 1-16.
1407. ANSARI, M. A. A. & SANT, G. K. (1943), "A study of soil heterogeneity in relation to size and shape of plots in wheat field at Raya (Muttra District)", *Indian J. Agric. Sci.*, **13**, 652-6.
1408. BAKER, G. A. (1946), "Distribution of the ratio of sample range to sample standard deviation for normal and combinations of normal distributions", *Ann. Math. Statist.*, **17**, 366-9.
1409. BAKER, G. A. & KLEIBER, M. (1944), "Characteristics of the daily weights of sexually mature rats on a constant diet", *Growth*, **8**, 159-67.
1410. BAKER, M. L., HAZEL, L. N. & REINMILLER, C. F. (1943), "The relative importance of heredity and environment in the growth of pigs at different ages", *J. Anim. Sci.*, **2**, 3-13.
1411. BALDWIN, E. M. (1946), "Table of percentage points of the *t*-distribution", *Biometrika*, **33**, 362.
1412. BANCROFT, T. A. (1944), "On biases in estimation due to the use of preliminary tests of significance", *Ann. Math. Statist.*, **15**, 190-204.
1413. BARNARD, G. A. (1947), "Significance tests for 2×2 tables", *Biometrika*, **34**, 123-38.
1414. BARNARD, G. A. (1947), " 2×2 . A note on E. S. Pearson's paper", *Biometrika*, **34**, 168-9.
1415. BARNARD, G. A. (1947), "The meaning of a significance level", *Biometrika*, **34**, 179-82.
1416. BARTLETT, M. S. (1947), "Multivariate Analysis", *J. R. Statist. Soc. Suppl.*, **9**, 176-97.
1417. BARTLETT, S. & BLAXTER, K. L. (1947), "The value of urea as a substitute for protein in the rations of dairy cattle. I. Field trials with dairy cows", *J. Agric. Sci.*, **37**, (1), 32-44.
1418. BATEMAN, A. J. (1947), "Contamination in seed crops. III. Relation with isolation distance", *Heredity*, **1**, 303-36.
1419. BATEN, W. D. & TROUT, G. M. (1946), "A critical study of the summation of difference-in-rank method of determining proficiency in judging dairy products", *Biometrics Bull.*, **2**, 67-9.
1420. BENJAMIN, B. (1943), "Height and weight measurements of school children", *J. Hyg.*, **43**, 55-68.
1421. BERKSON, J. (1943), "Experience with tests of significance: a reply to Professor R. A. Fisher", *J. Amer. Statist. Ass.*, **38**, 242-6.
1422. BERKSON, J. (1946), "Approximation of chi-square by 'probits' and by 'logits'", *J. Amer. Statist. Ass.*, **41**, 70-4.
1423. BEYER, P. & TREMOLIERES, J. (1944), "Study on maternity and its relation to certain living conditions in Paris in 1942-43", *Rec. Trav. Inst. Nat. Hyg. Paris*, **1**, 3, 57-147.
1424. BHATTACHARYYA, B. C. (1944), "On an aspect of Pearsonian system of curves and a few analogies", *Sankhyā : Indian J. Statist.*, **6**, 415-8.
1425. BHATTACHARYYA, K. N. (1943), "A note on two-fold triple systems", *Sankhyā : Indian J. Statist.*, **6**, 313-4.
1426. BLAXTER, K. L. & FRENCH, T. H. (1944), "Experiments on the use of home-grown foods for milk production. III. The effect of over- and under-feeding during mid-lactation. IV. Methods of feeding bulky foods", *J. Agric. Sci.*, **34** (4), 213-6, 217-22.
1427. BLISS, C. I. (1945), "The combined slope in comparative tests of tibia and toe ash in the chick assay for vitamin D", *Poult. Sci.*, **24**, 534-41.
1428. BLISS, C. I. (1947), " 2×2 factorial experiments in incomplete groups for use in biological assays", *Biometrics Bull.*, **3**, 69-88.
1429. BLISS, C. I. & CATTELL, M. (1943), "Biological assay", *Annu. Rev. Physiol.*, **5**, 479-539.
1430. BLUNN, C. T. & GRANDSTAFF, J. O. (1945), "Comparison of the yields of side samples from weanling and yearling sheep", *J. Anim. Sci.*, **4**, 122-7.
1431. BOERGER, A. (1946), "The science of agronomy. Advice on method", *J. Pou. Orfila*, pp. xix + 538.
1432. BOND, T. E. T. (1947), "Some Ceylon examples of the logarithmic series and the index of diversity of plant and animal populations", *Ceylon J. Sci.*, **12**, Sect. A, 195-202.
1433. BONNIER, G. (1946), "The sire index", *Acta. Agric. Suec. (Stockh.)*, **1**, 321-34.
1434. BONNIER, G., HANSSON, A. & DÜRING, T. (1946), "The efficiency of the (uniovular) twin method in experimental research", *K. LandtbrAkad. Handl. Stockh.*, **85**, 455-67.
1435. BONNIER, G., HANSSON, A. & JARL, F. (1946), "Studies in the variations of the calory content of milk", *Acta. Agric. Suec. (Stockh.)*, **2**, 159-69.
1436. BOONSTRA, A. E. H. R. (1943), "Correlation in practice", *Landbouwk. Tijdschr. Wageningen.*, **55**, 639-59.
1437. BORDEN, R. (1943), "Yield variations with special reference to border effects in field tests", *Hawaii Plant Rec.*, **47**, 195-203.
1438. BORDEN, R. J. (1943), "Replication: The safeguard for uncontrolled variation", *Hawaii Plant Rec.*, **47**, 135-53.
1439. BOSE, R. C. (1947), "Recent work on 'incomplete block designs' in India", *Biometrics Bull.*, **3**, 176-8.
1440. BOYCE, S. W. (1945), "Statistical studies on New Zealand wheat trials. I. The efficiency of lattice design", *N.Z. J. Sci. Tech.*, **27**, Sect. A, 270-5.
1441. BOYCE, S. W. (1945), "Statistical studies on New Zealand wheat trials. II. The analysis of lattice trials with incomplete data", *N.Z. J. Sci. Tech.*, **27**, Sect. A, 276-80.
1442. BOYD, D. A. & MATHISON, I. (1947), "Fertilizer application. Findings of the survey of fertilizer practice", *Agriculture*, **54**, 325-8.
1443. BRIEGER, F. G. (1946), "Unilateral and bilateral limits in statistical analysis", *Bragantia, Sao Paulo*, **6**, 479-545.
1444. BRIQUET, R. (JR.) & LUSH, J. L. (1947), "Heritability of amount of spotting in Holstein-Friesian cattle", *J. Hered.*, **38**, 99-105.

1951]

1445. BROUWER, E. (1945), "On high correlations and their biological significance", *Landbouwk. Tijdschr. Wageningen*, 56, 504-7.
1446. BROUWER, E. (1946), "Complex indices for butter", *Acta. Brev. Neerl. Physiol.*, 13, 74-7.
1447. BROWN, G. W. (1947), "Discriminant functions", *Ann. Math. Statist.*, 18, 514-28.
1448. CALVET, R. P. & ZULUETA, M. M. DE (1946), "Statistical methods for comparing a large number of varieties", *Bol. Inst. Invest. Exp. Agron. For., Madr.*, 14, 29-62.
1449. CAPÓ, B. G. (1944), "A new method of performing field trials", *J. Agric. P. Rico*, 28, 22-34.
1450. CAPÓ, B. G. (1944), "A method of interpreting the results of field trials", *J. Agric. P. Rico*, 28, 7-21.
1451. CARTER, A. H. (1947), "Approximation to percentage points of the z-distribution", *Biometrika*, 34, 352-8.
1452. CASHEN, R. O. (1947), "The influence of rainfall on the yield and botanical composition of permanent grass at Rothamsted", *J. Agric. Sci.*, 37, 1-10.
1453. CAVALLI, L. L. & MAGNI, C. (1947), "Methods of analysing the virulence of bacteria and viruses for genetical purposes", *Heredity*, 1, 127-32.
1454. CHAMBERS, E. G. (1943), "Statistical calculation for beginners", *Cambridge University Press*, 1-118.
1455. CHAMBERS, E. G. (1946), "Statistical techniques in applied psychology", *Biometrika*, 33, 269-73.
1456. COCHRAN, W. G. (1943), "Analysis of variance for percentages based on unequal numbers", *J. Amer. Statist. Ass.*, 38, 287-301.
1457. COCHRAN, W. G. (1943), "Some additional lattice square designs", *Res. Bull. Ia. Agric. Exp. Sta.*, 318, 731-48.
1458. COCHRAN, W. G. (1943), "The comparison of different scales of measurement for experimental results", *Ann. Math. Statist.*, 14, 205-16.
1459. COCHRAN, W. G. (1943), "Some developments in statistics", *Chronica Botanica*, 7, 383-6.
1460. COCHRAN, W. G. (1947), "Some consequences when the assumptions for the analysis of variance are not satisfied", *Biometrics Bull.*, 3, 22-38.
1461. COMSTOCK, R. E. (1943), "Over-estimation of mean squares by the method of expected numbers", *J. Amer. Statist. Ass.*, 38, 335-40.
1462. CONAGIN, A. (1947), "Use of statistical tests in agricultural experimentation", *Rev. Agric., S. Paulo*, 22, 340-56.
1463. CONAGIN, A. (1947), "Some statistical notions", *Rev. Agric., S. Paulo*, 22, 119-34.
1464. COOK, R. L., MILLAR, C. E. & ROBERTSON, L. S. (1946), "A crop rotation field layout with an illustration of the statistics involved in combining several years' data", *Proc. Soil Sci. Soc. Amer.*, 10, 213-8.
1465. CORNISH, E. A. (1943), "The recovery of inter-block information in quasi-factorial designs with incomplete data. I. Square, triple, and cubic lattices", *Bull. Counc. Sci. Industr. Res. Aust.*, 158, 22.
1466. CORNISH, E. A. (1944), "The recovery of inter-block information in quasi-factorial designs with incomplete data. II. Lattice squares", *Bull. Counc. Sci. Industr. Res. Aust.*, 175, 1-19.
1467. COWDEN, D. J. (1943), "Correlation concepts and the Doolittle method", *J. Amer. Statist. Ass.*, 38, 327-34.
1468. COX, G. M. & COCHRAN, W. G. (1946), "Designs of greenhouse experiments for statistical analysis", *Soil Sci.*, 62, 87-98.
1469. CRAMÉR, H. (1946), "Mathematical methods of statistics", *Princeton University Press*, xvi+575.
1470. CRANE, M. B., et al. (1944), "Application of genetics to plant and animal breeding", *Nature, Lond.*, 153, 780-3.
1471. CRIST, J. W. (1943), "The coefficient of contingency for horticultural research", *Proc. Amer. Soc. Hort. Sci.*, 42, 484-6.
1472. CRUMP, S. L. (1946), "The estimation of variance components in analysis of variance", *Biometrics Bull.*, 2, 7-11.
1473. CURTISS, J. H. (1943), "On transformations used in the analysis of variance", *Ann. Math. Statist.*, 14, 107-22.
1474. DARLINGTON, C. D. & MATHER, K. (1944), "Chromosome balance and interaction in Hyacinthus", *J. Genet.*, 46, 52-61.
1475. DAVID, F. N. (1947), "A χ^2 'smooth' test for goodness of fit", *Biometrika*, 34, 299-310.
1476. DAVIES, J. F. (1945), "A method for estimating the weight of roots of green manure crops", *J. Amer. Soc. Agron.*, 37, 661-2.
1477. DAVIES, O. L. (1947), *Statistical Methods in Research and Production*, Oliver & Boyd, London, xi+292.
1478. DAVIS, J. F., BATES, W. D. & COOK, R. L. (1946), "The effect of time of application and levels of nitrogen, phosphorus, and potash on the growth of sugar beets with a detailed statistical procedure of confounding in a $3 \times 3 \times 3$ design", *Tech. Bull. Michigan Agric. Exp. Sta.*, 203, 40.
1479. DE FINA, A. L. (1943), "A graphical and numerical index for determining the degree of efficiency of agricultural varieties", *Rev. Fac. Agron. La Plata*, 25, 21-54.
1480. DE LURY, D. B. (1946), "The analysis of Latin squares when some observations are missing", *J. Amer. Statist. Ass.*, 41, 370-89.
1481. DE LURY, D. B. (1947), "On the estimation of biological populations", *Biometrics Bull.*, 3, 145-67.
1482. DICE, L. R. (1945), "Measures of the amount of ecologic association between species", *Ecology*, 26, 297-302.
1483. DICKEY, H. C. & LABARTHE, P. (1945), "Predicting the transmitting ability of young dairy sires for milk production, butterfat test, and butterfat production", *J. Dairy Sci.*, 28 (12), 893-900.

1484. DIETZ, A. A. (1946), "Composition of normal bone marrow in rabbits", *J. Biol. Chem.*, **165**, 505-11.
1485. DIXON, W. J. (1944), "Further contributions to the problem of serial correlation", *Ann. Math. Statist.*, **15**, 119-44.
1486. DIXON, W. J. & MOOD, A. M. (1946), "The statistical sign test", *J. Amer. Statist. Ass.*, **41**, 557-66.
1487. DYSON, E. J. (1943), "A note on kurtosis", *J. R. Statist. Soc.*, **106**, 360-1.
1488. EISENHART, C. (1947), "The assumptions underlying the analysis of variance", *Biometrics Bull.*, **3**, 1-21.
1489. ELFVING, G. (1947), "The asymptotical distribution of range in samples from a normal population", *Biometrika*, **34**, 111-9.
1490. ENSMINGER, M. E., PHILLIPS, R. W., SCHOTT, R. G. & PARSONS, C. H. (1943), "Measuring performance of progeny of rams in a small flock", *J. Anim. Sci.*, **2**, 157-65.
1491. EPSTEIN, B. & CHURCHMAN, C. W. (1944), "On the statistics of sensitivity data", *Ann. Math. Statist.*, **15**, 90-6.
1492. ERLEE, T. J. D. (1943), "Two problems in statistical variation based on 203 blank experiments, harvested in 1931, on sugar cane in Java", *Landbouwk. Tijdschr. Wageningen.*, **55**, 660-8.
1493. FIELLER, E. C. (1947), "Some remarks on the statistical background in bio-assay", *Analyst.*, **72**, 37-43.
1494. FINNEY, D. J. (1946), "Recent developments in the design of field experiments. I. Split-plot confounding. II. Unbalanced split-plot confounding. III. Fractional replication", *J. Agric. Sci.*, **36**, 56-62, 63-8, 184-91.
1495. FINNEY, D. J. (1946), "The analysis of a factorial series of insecticidal tests", *Ann. Appl. Biol.*, **33**, 160-6.
1496. FINNEY, D. J. (1946), "Standard errors of yields adjusted for regression on an independent measurement", *Biometrics Bull.*, **2**, 53-5.
1497. FINNEY, D. J. (1946), "Orthogonal partitions of the 5×5 Latin squares", *Ann. Eugen.*, **13**, 1-3.
1498. FINNEY, D. J. (1946), "Orthogonal partitions of the 6×6 Latin squares", *Ann. Eugen.*, **13**, 184-96.
1499. FINNEY, D. J. (1946), "Latin squares of the sixth order", *Experientia, Basel*, **2**, 404-5.
1500. FINNEY, D. J. (1946), "A note on 'missing-plot techniques'", *Biometrics Bull.*, **2**, 94.
1501. FINNEY, D. J. (1947), "Statistical aspects of microbiological assays", *Biochem. J.*, **41**, 5-7.
1502. FINNEY, D. J. (1947), "The construction of confounding arrangements", *Emp. J. Exp. Agric.*, **15**, 107-12.
1503. FINNEY, K. F. & YAMAZAKI, W. T. (1946), "Water retention capacity as an index of the loaf volume potentialities and protein quality of hard red winter wheat", *Cereal Chem.*, **23**, 416-27.
1504. FISHER, R. A. (1943), "Statistical analysis of initial and final weights", *Vet. Rec.*, **55**, 3-4.
1505. FISHER, R. A. & YATES, F. (1943), *Statistical Tables for Biological, Agricultural and Medical Research*. Oliver & Boyd, Ltd., 2nd ed., vii + 98.
1506. FISHER, R. A., CORBET, A. S. & WILLIAMS, C. B. (1943), "The relation between the number of species and the number of individuals in a random sample of an animal population", *J. Anim. Ecol.*, **12**, 42-58.
1507. FLEISCH, A. & POSTERNAK, J. (1943), "Standard curves of dark adaptation and their evaluation", *Helv. Phys. Acta.*, **1**, 421-36.
1508. FORSAITH, C. C. (1943), "Statistics for foresters", *Tech. Bull. N.Y. St. Coll. For.*, **16**, 1-69.
1509. GAALAAS, R. F. (1947), "A study of heat tolerance in Jersey cows", *J. Dairy Sci.*, **30**, 79-85.
1510. GAINES, W. L. (1943), "Feeding standard equations for cows and goats in milk", *J. Anim. Sci.*, **2**, (4), 304-13.
1511. GEARY, R. C. (1947), "The frequency distribution of $\sqrt{b_1}$ for samples of all sizes drawn at random from a normal population", *Biometrika*, **34**, 68-97.
1512. GEARY, R. C. (1947), "Testing for normality", *Biometrika*, **34**, 209-42.
1513. GEARY, R. C. & WORLLEDGE, J. P. G. (1947), "On the computation of universal moments of tests of statistical normality derived from samples drawn at random from a normal universe. Application to the calculation of the seventh moment of b_2 ", *Biometrika*, **34**, 98-110.
1514. GEIRINGER, H. (1944), "On the probability theory of linkage in Mendelian heredity", *Ann. Math. Statist.*, **15**, 25-57.
1515. GHOSH, B. (1946), "Measures of heterogeneity in agricultural and similar fields, and their inter-relations", *Sci. and Cult.*, **11**, 382-3.
1516. GILBERT, S. M. (1945), "The Coffee Research and Experiment Station, Tanganyika Territory: A brief survey of the first ten years' work", *Emp. J. Exp. Agric.*, **13**, 11-24.
1517. GOSSETT, W. S. (1942), "Student's collected papers". Cambridge University Press, xiv + 224.
1518. GOULDEN, C. H. (1944), "A uniform method of analysis for square lattice experiments", *Sci. Agric.*, **25**, 115-36.
1519. GOLDBERG, H. & LEVINE, H. (1946), "Approximate formulae for the percentage points and normalization of t and z^2 ", *Ann. Math. Statist.*, **17**, 216-25.
1520. GRANDSTAFF, J. O. & BLUNN, C. T. (1945), "Evaluating fleece quality of Navajo sheep from small samples", *J. Agric. Res.*, **71**, 183-92.
1521. GRAY, P. (1947), "The effect of the death rate in biological experiments on the validity of observations, and on the test for association", *Arch. Biochem.*, **13**, 461-74.
1522. GRIDGEMAN, N. T. (1943), "The technique of the biological vitamin A assay", *Biochem. J.*, **37**, 127-32.
1523. GRIDGEMAN, N. T. (1944), "Mathematics of biological assay", *Nature*, **153**, 461-2.
1524. GRIDGEMAN, N. T. (1945), "Special designs of vitamin D assays. The potencies of vitamins D₂ and D₃", *Quart. J. Pharm.*, **18**, 13-23, 24-9.

1951]

1525. GROOTENHUIS, J. A. & POST, J. J. (1946), "The suitability of the Latin square for trials of a fairly simple character", *Meded. Direct. Tuinb.*, 173-5.
1526. GRUBBS, F. E. (1944), "On the distribution of the radial standard deviation", *Ann. Math. Statist.*, 15, 75-81.
1527. GUMBEL, E. J. (1943), "On the reliability of the classical χ^2 test", *Ann. Math. Statist.*, 14, 253-63.
1528. GUMBEL, E. J. (1944), "Ranges and mid-ranges", *Ann. Math. Statist.*, 15, 414-22.
1529. HALLGREN, G. (1946), "A method of determining the co-variation between precipitation and crop yield", *K. Lantbrukshögsk. Ann.*, 13, 104-13.
1530. HAMMING, G. (1947), "Graphic correction of a Fisher experiment", *Landbouwk. Tijdschr. Wageningen.*, 59, 496-504.
1531. HAMMOND, W. H. (1944), "Factor analysis as an aid to nutritional assessment", *J. Hyg.*, 43, 395-9.
1532. HARDY, J. I. & WOLF, H. W. (1947), "Wool fibre density of Shropshire lambs", *J. Anim. Sci.*, 6, 72-82.
1533. HARSHBARGER, B. (1945), "On the analysis of a certain 6×6 four-group lattice design using the recovery of inter-block information", *Ann. Math. Statist.*, 16, 387-90.
1534. HARSHBARGER, B. (1946), "Preliminary report on the rectangular lattices", *Biometrics Bull.*, 2, 115-9.
1535. HARTMAN, J. & STAIR, E. C. (1946), "Correlation of means and standard deviations in tomato field experiments", *Proc. Amer. Soc. Hort. Sci.*, 48, 337-40.
1536. HAZEL, L. N., BAKER, M. L. & REINMILLER, C. F. (1943), "Genetic and environmental correlations between the growth rates of pigs at different ages", *J. Anim. Sci.*, 2, 118-28.
1537. HAZEL, L. N. & TERRILL, C. E. (1946), "Heritability of weaning traits in range Colombia, Corriedale and Targhee lambs", *J. Anim. Sci.*, 5, 371-7.
1538. HENDRICKS, W. A. & SCHOLL, J. C. (1943), "Techniques in measuring joint relationships. The joint effects of temperature and precipitation on corn yields", *Tech. Bull. N. C. Agric. Exp. Sta.*, 74, 1-34.
1539. HERCHENRODER, M. V. M. (1943), "A review of modern practical methods of analysis in statistics", *Rev. Agric. Maurice*, 22, 51-68.
1540. HETZER, H. O., DICKERSON, G. E. & ZELLER, J. H. (1944), "Heritability of type in Poland China swine as evaluated by scoring", *J. Anim. Sci.*, 3, 390-8.
1541. HILDEBRAND, F. C. & KOEHN, R. C. (1944), "Sources of error in the determination of the protein content of bulk wheat", *Cereal Chem.*, 21, 370-4.
1542. HINMAN, W. F., TUCKER, R. E., JANS, L. M. & HALLIDAY, E. G. (1946), "Excessively high riboflavin retention during braising of beef. A comparison of methods of assay", *Industr. Engng. Chem. (Anal. Ed.)*, 18, 296-301.
1543. HOBLYN, T. N. (1945), "The design of field experiments with cocoa", *Rep. Cocoa Res. Conf. London*, May-June, 164-8.
1544. HOEL, P. G. (1945), "Testing the homogeneity of Poisson frequencies", *Ann. Math. Statist.*, 16, 362-8.
1545. HOLLANDER, W. F. (1946), "Notes on graphic biometric comparisons of samples", *Amer. Nat.*, 80, 494-6.
1546. HOLMES, W. J. (1946), "Night Vision. I. A comparison of the scotopic visual ratings of young Japanese and Caucasian adults living in Hawaii. II. A comparison and critique of various procedures used for night vision testing", *Arch. Ophthalm.*, 36, 141-54, 302-14.
1547. HOMEYER, P. G. & BLACK, C. A. (1947), "Sampling replicated field experiments on oats for yield determinations", *Proc. Soil Sci. Soc. Amer.*, 11, 341-4.
1548. HOMEYER, P. G., CLEM, M. A. & FEDERER, W. T. (1947), "Punched card and calculating machine method for analysing lattice experiments including lattice squares and the cubic lattice", *Res. Bull. Ia. Agric. Exp. Sta. Statist. Sect.*, 374.
1549. HOUGH, L. F. & WELKER, E. L. (1943), "Combining genetically different samples for correlation analysis", *Proc. Amer. Soc. Hort. Sci.*, 43, 155-9.
1550. HOUSEMAN, E. E. (1943), "Methods of computing a regression of yield on weather", *Res. Bull. Ia. Agric. Exp. Sta.*, 302, 863-904.
1551. HSU, P. L. (1943), "Some simple facts about the separation of degrees of freedom in factorial experiments", *Sankhyā: Indian J. Statist.*, 6, 253-4.
1552. HUSSAIN, Q. M. (1945), "Symmetrical incomplete block designs with $\lambda = 2$, $k = 8$ or 9 ", *Bull. Calcutta Math. Soc.*, 37, 115-23.
1553. HUTT, F. B. & BOZIVICH, H. (1946), "On the supposed matroclinous inheritance of egg size in fowl", *Poult. Sci.*, 25, 554-61.
1554. IMMER, F. R. (1945), "Some uses of statistical methods in plant breeding", *Biometrics Bull.*, 1, 13-5, 28.
1555. IRWIN, J. O. (1943), "On the calculation of the error of biological assays", *J. Hyg.*, 43, 121-8.
1556. IRWIN, J. O. (1944), "A statistical examination of the accuracy of vitamin A assays. An analysis of three co-operative experiments designed to ascertain the value of the conversion factor for transforming spectrophotometric values into international units", *J. Hyg.*, 43, 291-314.
1557. IRWIN, J. O. & KENDALL, M. G. (1944), "Sampling moments of moments for a finite population", *Ann. Eugen.*, 12, 138-42.
1558. IYENGAR, R. (1944), "Variation of fibre length in a bulk sample of cotton and in a single seed of the bulk", *Technol. Leaflet. Indian Cott. Comm. Technol. Lab.*, 6, 3.
1559. JACOB, W. C. (1944), "Statistical analysis of factorial experiments", *Bol. Minist. Agric. Rio de J.*, 33, 41-56.

1560. JAMES, E. (1947), "A modification of the formulae for regression", *J. Amer. Soc. Agron.*, **39**, 545-6.
1561. JENSS, R. M. (1945), "Statistical methods in anthropometric studies in the field of nutritional research", *Amer. J. Publ. Hlth.*, **35**, 1053-6.
1562. JOHNSON, I. J. & MURPHY, H. C. (1943), "Lattice and lattice square designs with oat uniformity data and in variety trials", *J. Amer. Soc. Agron.*, **35**, 291-305.
1563. JONES, A. E. (1946), "A useful method for the routine estimation of dispersion from large samples", *Biometrika*, **33**, 274-82.
1564. KAC, M. (1945), "A remark on undependence of linear and quadratic forms involving independent Gaussian variables", *Ann. Math. Statist.*, **16**, 400-1.
1565. KEMPTHORNE, O. (1946), "The analysis of a series of experiments by the use of punched cards", *J. R. Statist. Soc. Suppl.*, **8**, 118-27.
1566. KEMPTHORNE, O. (1946), "The use of a punched card system for the analysis of survey data, with special reference to the analysis of the National Farm Survey", *J. R. Statist. Soc.*, **109**, 284-95.
1567. KEMPTHORNE, O. (1947), "A simple approach to confounding and fractional replication in factorial experiments", *Biometrika*, **34**, 255-72.
1568. KEMPTHORNE, O. (1947), "A note on differential responses in blocks", *J. Agric. Sci.*, **37**, 245-8.
1569. KEMPTHORNE, O. (1947), "Recent developments in the design of field experiments. IV. Lattice squares with split-plots", *J. Agric. Sci.*, **37**, 156-62.
1570. KENDALL, M. G. (1943), *The Advanced Theory of Statistics*, Charles Griffin & Co. Ltd., 1st ed., xii + 457.
1571. KENDALL, M. G. (1946), *The Advanced Theory of Statistics*, Charles Griffin & Co., Ltd. 2nd ed., vii + 521.
1572. KINCAID, C. M., LITTON, G. W. & HUNT, R. E. (1945), "Some factors that influence the production of steers from pasture", *J. Anim. Sci.*, **4**, 164-73.
1573. KISHEN, K. (1947), "On fractional replication of the general symmetrical factorial design", *Curr. Sci.*, **16**, 138-9.
1574. KNAPP, B. (JR.) & NORDSKOG, A. W. (1946), "Heritability of growth and efficiency in beef cattle", *J. Anim. Sci.*, **5**, 62-70.
1575. KOVATS, L. T. (1943), "Principles of up-to-date field experimentation", *Rep. Hung. Agric. Exp. Sta.*, **46**, 183-95.
1576. KRISHNA IYER, P. V. (1945), "The distribution of the mean of samples from a rectangular population", *Curr. Sci.*, **14**, 18-9.
1577. KRISHNASWAMI AYYANGAR, A. A. (1943), "Statistical formulae", *Curr. Sci.*, **12**, 145.
1578. KRISHNASWAMI AYYANGAR, A. A. (1945), "Interaction formulae, in analysis of variance", *Curr. Sci.*, **14**, 35.
1579. KRIZENECKY, J. & KUDLICKA, K. (1949), "Effect of length of dry period on the birthweight of calves", *Z. Tierz. Zücht Biol.*, **56**, 299-320.
1580. VAN DER LAAN, E. (1943), "Proceedings of the study circle for experimental methods", *Landbouwk. Tijdschr. Wageningen.*, **55**, 621.
1581. LAMAS, P. J. A. (1944), "The number of frequencies and accuracy in field trials", *Granos.*, **8**, 3-16.
1582. LERNER, I. M. & TAYLOR, L. W. (1944), "Early recognition of superior families", *Poult. Sci.*, **23**, 413-7.
1583. LERNER, I. M. (1945), "'Nicking' in relation to sexual maturity of S.C.W. Leghorns", *Amer. Nat.*, **79**, 152-9.
1584. LETESTU, S. (1948), "Note on discriminating analysis", *Experientia, Basel*, **4**, 22-3.
1585. LEVENE, H. & WOLFOWITZ, J. (1944), "The covariance matrix of runs up and down", *Ann. Math. Statist.*, **15**, 58-69.
1586. LI, J. C. R. (1944), "Design and statistical analysis of some confounded factorial experiments", *Res. Bull. Ia. Agric. Exp. Sta.*, **333**, 453-92.
1587. LONKA, T. (1945), "The selection of dairy cows under uncommonly poor feeding conditions", *Valt. Maatalousk. Julk.*, **125**, 47.
1588. LONKA, T. (1946), "Progeny testing of sires", *Valt. Maatalousk. Julk.*, **127**.
1589. LORD, E. (1947), "The use of range in place of standard deviation in the *t*-test", *Biometrika*, **34**, 41-67.
1590. LOVE, H. H. (1943), "Experimental methods in agricultural research", *Agric. Exp. Sta. Univ. P. Rico: Rio Piedras, P. Rico*, v + 229.
1591. LOVE, A. & LOVE, D. (1943), "The significance of differences in the distribution of diploids and polyploids", *Hereditas, Lund.*, **29**, 145-61.
1592. LUSH, J. L. (1944), "The optimum emphasis on dams' record when proving dairy sires", *J. Dairy Sci.*, **27**, 937-51.
1593. MADOW, W. G. & MADOW, L. H. (1944), "On the theory of systematic sampling, I", *Ann. Math. Statist.*, **15**, 1-24.
1594. MAHALANOBIS, P. C. (1944), "On large scale sample surveys", *Philos. Trans., Ser. B*, **231**, 329-451.
1595. MAHALANOBIS, P. C. (1946), "Use of small size plots in sample surveys for crop yields", *Nature, Lond.*, **158**, 798-9.
1596. MALLIK, A. K., SATAKOPAN, V. & RAO, S. G. (1945), "A study on the estimation of the yield of wheat by sampling", *Indian J. Agric. Sci.*, **15**, 219-26.
1597. MARINO, A. E. (1943), "Relation between the number of leaves and earliness in maize under different times of sowing", *Rev. Argent. Agron.*, **10**, 239-43.

1951]

1598. MARINO, A. E. (1947), "Statistical study of the correlation between rainfall and maize yield", *Rev. Argent. Agron.*, **14**, 189-209.
1599. MARTINS, R. G. (1945), "Agricultural experimentation", *Bol. Minist. Agric. Rio de J.*, **34**, 1-14.
1600. MASON, E. D., DEVADAS, R. & FRIMODT-MOLLER, J. (1946), "The effects on growth in rats of butter and ragi (*Ecleusine coracana*), separately and combined, as supplements to the poor rice diet of South India", *Indian J. Med. Res.*, **34**, 45-8.
1601. MATHER, K. (1943), *Statistical Analysis in Biology*. Methuen & Co., Ltd., 247.
1602. MATHER, K. (1946), *Statistical Analysis in Biology*. Methuen & Co., Ltd., 2nd Ed., 267.
1603. MATHISEN, H. C. (1943), "A method of testing the hypothesis that two samples are from the same population", *Ann. Math. Statist.*, **14**, 188-94.
1604. MENEZES, O. B. DE (1944), "Genetic studies of the pigeon pea (*Cajanus indicus*). Spacing and competition in varieties", *Rev. Agric. Piracicaba*, **19**, 399-412.
1605. MISES, R. v. (1943), "On the problem of testing hypotheses", *Ann. Math. Statist.*, **14**, 238-52.
1606. MITSCHERLICH, E. A. (1947), "A method for eliminating the systematic error due to soil heterogeneity in drainage and irrigation experiments", *Z. Pfl-Ernähr. Dung.*, **37**, 259-64.
1607. MOLINA, E. C. (1946), "Some fundamental curves for the solution of sampling problems", *Ann. Math. Statist.*, **17**, 325-35.
1608. MYERS, W. M. (1943), "Analysis of variance and covariance of chromosomal association and behaviour during the meiosis in clones of *Dactylis glomerata*", *Bot. Gaz.*, **104**, 541-52.
1609. NAIR, K. R. (1943), "Certain inequality relationships among the combinatorial parameters of incomplete block designs", *Sankhyā: Indian J. Statist.*, **6**, 255-9.
1610. NAIR, K. R. (1944), "The recovery of inter-block information in incomplete block designs", *Sankhyā: Indian J. Statist.*, **6**, 383-90.
1611. NAIR, K. R. (1944), "Statistical notes for agricultural workers. No. 27. Calculation of standard errors and tests of significance of different types of treatment comparisons in split-plot and strip arrangements of field experiments", *Indian J. Agric. Sci.*, **14**, 315-9.
1612. NANDA, D. (1947), Discussion, *Biometrics Bull.*, **3**, 180.
1613. NIELSEN, E. L. (1944), "Analysis of variation in *Panicum virgatum*", *J. Agric. Res.*, **69**, 327-53.
1614. NISSEN, Ø. & OTTESTAD, P. (1943), "On the analysis of variance and the effect of non-normality", *Meld. Norg. LandbrHøisk.*, **23**, 475-88.
1615. NISSEN, Ø. (1947), "The interaction between neighbouring plots in root experiments", *Meld. Norg. LandbrHøisk.*, **27**, 155-64.
1616. NORDSKOG, A. W., CLARK, R. T. & VAN HORN, L. (1945), "Sampling wool clips for clean yield by the core boring method", *J. Anim. Sci.*, **4**, 113-21.
1617. OLBRYCHT, T. M. (1943), "The statistical basis of selection in animal husbandry. Studies on life performance of brood sows. I. An analysis of variance and covariance of progeny born and reared", *J. Agric. Sci.*, **33**, 28-43.
1618. OLBRYCHT, T. M. (1943), "The statistical basis of selection in animal husbandry. Studies on life performance of brood sows. II. The judging of brood sows by their number of offspring born and reared in the earliest litters", *J. Agric. Sci.*, **33**, 74-84.
1619. OLIVEIRA, A. J. DE (1945), "Uniformity trials. A preliminary study with *Lupinus luteus* L. at Sacavém", *Agron. Lusit.*, **7**, 207-44.
1620. PANSE, V. G. & AYACHIT, G. R. (1944), "Ten per cent. probability of z and the variance ratio", *Indian J. Agric. Sci.*, **14**, 244-7.
1621. PANSE, V. G. (1946), "Plot-size in yield surveys on cotton", *Curr. Sci.*, **15**, 218-9.
1622. PANSE, V. G. (1947), "Plot-size in yield surveys", *Nature, Lond.*, **159**, 820.
1623. PATAU, K. & TIMOFEEFF-RESSOVSKY, N. W. (1943), "Statistical testing of the difference in the temperature coefficients of high and normal mutation rates, together with an example for the planning of temperature experiments", *Z. Indukt. Abstamm.-u. Verblehre.*, **81**, 62-71.
1624. PEARCE, S. C. (1944), "Sampling methods for the measurement of fruit crops", *J. R. Statist. Soc.*, **107**, 117-26.
1625. PEARSON, E. S. (1947), "The choice of statistical tests illustrated on the interpretation of data classed in a 2×2 table", *Biometrika*, **34**, 139-63.
1626. PENROSE, L. S. (1947), "Some notes on discrimination", *Ann. Eugen.*, **13**, 228-37.
1627. PÉREZ CALVET, R., ZULUETA, M. M. & ANÓS, A. (1943), "Agricultural experimentation. Statistical principles and methods of operation", *Instituto Nacional de Investigaciones Agronómicas*, vii+272.
1628. PÉREZ CALVET, R. (1945), "A study on uniformity experiments and their use in the choice of replication plots", *Bol. Inst. Invest. Agron. For. Madr.*, **12**, 329-48.
1629. PETROV, A. P. (1942), "An investigation into the phytocoenose of deciduous woodlands", *Sovet. Bot.*, No. 4-5, 15-30.
1630. PETTERSON, H. (1943), "Plant breeding and forestry", *Skogen.*, **30**, 31-7.
1631. PHILLIPS, R. W., et al. (1943), "Seasonal variation in the semen of bulls", *Amer. J. Vet. Res.*, **4**, 115-9.
1632. PHILLIPS, R. W., et al. (1943), "Seasonal variation in the semen of sheep and goats", *Cornell Vet.*, **33**, 227-35.
1633. PHILLIPS, R. W. & STOEHR, J. A. (1945), "The accuracy of measurements and weights of sheep", *J. Anim. Sci.*, **4**, 311-6.
1634. PHIPPS, I. F., PUGSLEY, A. T., HOCKLEY, S. R., et al. (1944), "The analysis of cubic lattice designs in variational trials", *Bull. Counc. Sci. Industr. Res. Aust.*, **176**, 1-40.

1635. PLACKETT, R. L. (1947), "Limits of the ratio of mean range to standard deviation", *Biometrika*, **34**, 120-2.
1636. PLATT, J. R. (1943), "A mechanical determination of correlation coefficients and standard deviations", *J. Amer. Statist. Ass.*, **38**, 311-8.
1637. POHLE, E. M., HAZEL, L. N. & KELLER, H. R. (1944), "Sampling and measuring methods for determining fineness and uniformity in wool", *Circ. U.S. Dep. Agric.*, 704.
1638. POWERS, L. (1944), "Meiotic studies of crosses between *Fragaria ovalis* and $\times F. ananassa$ ", *J. Afric. Res.*, **69**, 435-48.
1639. PRABHU, S. S. & AMBLE, V. N. (1946), "Weaned versus unweaned—a statistical study of an experiment conducted on goats", *Indian J. Vet. Sci.*, **16**, 212-22.
1640. PROBST, A. H. (1943), "Border effect in soya bean nursery plots", *J. Amer. Soc. Agron.*, **35**, 662-6.
1641. RAO, C. R. (1945), "Familial correlations or the multivariate generalizations of the intraclass correlation", *Curr. Sci.*, **14**, 66-7.
1642. RAO, C. R. (1947), "General methods of analysis for incomplete block design", *J. Amer. Statist. Ass.*, **42**, 541-61.
1643. RAO, C. R. (1947), "Factorial experiments derivable from combinatorial arrangements of arrays", *J. R. Statist. Soc. Suppl.*, **9**, 128-40.
1644. RAO, C. R. (1943), "Quasi-Latin squares in experimental arrangements", *Curr. Sci.*, **12**, 322-3.
1645. RENBOURN, E. T. & BONSALE, F. F. (1946), "Observations on normal body temperatures in N. India", *Brit. Med. J.*, 909-14.
1646. RENDEL, J. M. (1943), "Variation in the weights of hatched and unhatched ducks' eggs. With appendices by J. B. S. Haldane. I. The coefficient of variation of egg volume. II. The interpretation of the greater variance of the unhatched eggs", *Biometrika*, **33**, 48-58.
1647. RICE, V. A. (1944), "A new method for indexing dairy bulls", *J. Dairy Sci.*, **27**, 921-36.
1648. RIDDLE, O. C. & BAKER, G. A. (1944), "Biases encountered in large-scale yield tests", *Hilgardia*, **16**, 1-14.
1649. RIGNEY, J. A. (1946), "Some statistical problems confronting horticultural investigators", *Proc. Amer. Soc. Hort. Sci.*, **48**, 351-7.
1650. ROBBINS, H. (1944), "On distribution-free tolerance limits in random sampling", *Ann. Math. Statist.*, **15**, 214-6.
1651. ROBERTS, I. F. & MCKENZIE, F. F. (1943), "Inter-relationships of semen characters and effect of frequency of ejaculation on semen production in young beef bulls", *J. Anim. Sci.*, **2**, 360.
1652. ROBINSON, J. L. & REISS, F. (1944), "The 1943 Iowa corn yield test", *Res. Bull. Ia. Agric. Exp. Sta.*, **358**, 852-903.
1653. ROESSLER, E. B. (1943), "Valid estimates of variance in the analysis of pooled data", *Proc. Amer. Soc. Hort. Sci.*, **42**, 481-3.
1654. ROESSLER, E. B. & LEACH, L. D. (1944), "Analysis of combined data for identical replicated experiments", *Proc. Amer. Soc. Hort. Sci.*, **44**, 323-8.
1655. RUSOFF, L. L. & PIERCY, P. L. (1946), "Blood studies of Louisiana dairy cows. II: Calcium, inorganic phosphorus, hemoglobin value, erythrocyte count, leucocyte count and differential leucocyte percentages", *J. Dairy Sci.*, **29**, 831-8.
1656. SALGADO, M. L. M. (1946), "Recent studies on the manuring of coconuts", *Trop. Agriculturist*, **102**, 206-18.
1657. SAUNDERS, A. R. (1944), "Efficiency of design in field experiment at Potchefstroom, S. Africa", *Emp. J. Exp. Agric.*, **12**, 157-62.
1658. SCHEFFÉ, H. (1944), "A note on the Behrens-Fisher test", *Ann. Math. Statist.*, **15**, 430-4.
1659. SCHEFFÉ, H. & TUKEY, J. W. (1944), "A formula for sample sizes for population tolerance limits", *Ann. Math. Statist.*, **15**, 217.
1660. SEATH, D. M. (1944), "A 2×2 factorial design for double reversal feeding experiments", *J. Dairy Sci.*, **27**, 159-64.
1661. SEATH, D. M. & MILLER, G. D. (1946), "The relative importance of high temperature and high humidity as factors influencing respiration rate, body temperature, and pulse rate of dairy cows", *J. Dairy Sci.*, **29**, 465-72.
1662. SEKAR, C. C. (1944), "Distribution of Fisher's g_1 for samples of three from a continuous rectangular distribution", *Curr. Sci.*, **13**, 10-1.
1663. SHOURIE, K. L. (1946), "Fluorine and dental caries in India", *Indian J. Med. Res.*, **34**, 97-104.
1664. SILLITTO, G. P. (1947), "The distribution of Kendall's τ coefficient of rank correlation in rankings containing ties", *Biometrika*, **34**, 36-40.
1665. SIMON, H. A. (1943), "Symmetric tests of the hypothesis that the mean of one normal population exceeds that of another", *Ann. Math. Statist.*, **14**, 149-54.
1666. SIMPSON, G. G. (1945), "Note on graphic biometric comparison of samples", *Amer. Nat.*, **79**, 95-6.
1667. SMYTHE, V. R. (1945), "Studies on the effects of transport and storage on the bacteriological quality of raw milk. I. The reduction of methylene blue by raw milk as influenced by time and temperature of storage", *Qd. J. Agric. Sci.*, **2**, 128-56.
1668. SNEDECOR, G. W. (1946), *Statistical Methods Applied to Experiments in Agriculture and Biology*. Collegiate Press, Inc., Ames, Iowa xvi+485.
1669. SNEDECOR, G. W. & HABER, E. S. (1946), "Statistical methods for an incomplete experiment on a perennial crop", *Biometrics Bull.*, **2**, 61-7.
1670. SOLOVJEV, A. A. (1946), "Methods of investigating the fat content of cows milk", *Trud. Vologodsk. Moloc. Inst.*, **7**, 127-45.

1951]

1671. STADTMAN, E. R., BARKER, H. A., HAAS, V. & MRAK, E. M. (1946), "Storage of dried fruit. Influence of temperature on deterioration of apricots", *Industr. Engng. Chem.*, **38**, 541-3.
1672. STEGGERDA, F. R. & MITCHELL, H. H. (1946), "Variability in the calcium metabolism and calcium requirements of adult human subjects", *J. Nutrit.*, **31**, 407-22.
1673. STEWART, A. B. (1947), "Memoranda on colonial fertilizer experiments. II. Planning and conduct of fertilizer experiments", *Colon. Office*, **214**, 3-9.
1674. SUKHATME, P. V. (1944), "Moments and product moments of moment-statistics for samples of finite and infinite populations", *Sankhyā: Indian J. Statist.*, **6**, 363-82.
1675. SUKHATME, P. V. (1945), "Random sampling for estimating rice yield in Madras province", *Indian J. Agric. Sci.*, **15**, 308-18.
1676. SUKHATME, P. V. (1946), "Bias in the use of small-size plots in sample surveys for yield", *Curr. Sci.*, **15**, 119-20.
1677. SUKHATME, P. V. (1947), "The problem of plot size in large-scale yield surveys", *J. Amer. Statist. Ass.*, **42**, 297-310.
1678. SUKHATME, P. V. (1947), "Use of small-size plots in yield surveys", *Nature, Lond.*, **160**, 542.
1679. TALEKAR, V. L. (1947), "New methods of obtaining squares of numbers", *Curr. Sci.*, **16**, 337-8.
1680. TAVARES, H. (1945), "Confidence in experimental results", *Bol. Sec. Agric., Pernambuco*, **12**, 293-8.
1681. TEDIN, O. (1945), "Small samples of a Poisson series", *Hereditas, Lund.*, **31**, 238-40.
1682. TENGEDY-KOVATS, L. (1943), "The principles of modern field experimentation technique", *Rep. Hung. Agric. Exp. Sta.*, **46**, 183-95.
1683. TERRILL, C. E., POHLE, E. M., EMIK, L. O. & HAZEL, L. N. (1945), "Estimation of clean-fleece weight from grease-fleece weight and staple length", *J. Agric. Res.*, **70**, 1-10.
1684. THOMSON, C. M. & MERRINGTON, M. (1946), "Tables for testing the homogeneity of a set of estimated variances", *Biometrika*, **33**, 296-304.
1685. THOROLD, C. A. (1947), "A study of yields, preparation out-turns, and quality in Arabica coffee. Part I. Yields", *Emp. J. Exp. Agric.*, **15**, 96-106.
1686. TORRIE, J. H. & DICKSON, J. G. (1943), "The use of statistical methods in quality evaluation of barley and malt data", *Cereal Chem.*, **20**, 579-94.
1687. TORRIE, J. H., SANDS, H. L. & LEITH, B. D. (1943), "Efficiency studies of types of design with small grain yield trials", *J. Amer. Soc. Agron.*, **35**, 645-61.
1688. TSAI, H. & CHOW, C. Y. (1943), "Studies on field plot technique in wheat", *Chinese J. Sci. Agric.*, **1**, 117-8.
1689. TYLER, W. J., CHAPMAN, A. B. & DICKERSON, G. E. (1947), "Sources of variation in the birth weight of Holstein-Friesian calves", *J. Dairy Sci.*, **30**, 483-98.
1690. UPHOLT, W. M. (1945), "Observations on wartime biometrics", *Biometrics Bull.*, **1**, 47-52.
1691. UVEN, M. J. VAN (1943), "Correlation I", *Landbouwk. Tijdschr. Wageningen.*, **55**, 622-9.
1692. UVEN, M. J. VAN (1943), "Correlation II", *Landbouwk. Tijdschr. Wageningen.*, **55**, 630-8.
1693. VAJDA, S. (1947), "Technique of the analysis of variance", *Nature, Lond.*, **160**, 27.
1694. VERMA, O. P., DILWALI, C. K. & THOMSON, A. M. (1947), "A feeding experiment on Indian army pioneer recruits, with special reference to the relative value of meat and milk in rations", *Indian J. Med. Res.*, **35**, 41-57.
1695. WADLEY, F. M. & SULLIVAN, W. N. (1943), "A study of the dosage mortality curve", *J. Econ. Ent.*, **36**, 367-72.
1696. WALD, A. (1943), "On the efficiency design of statistical investigation", *Ann. Math. Statist.*, **14**, 134-40.
1697. WALD, A. (1944), "On a statistical problem arising in the classification of an individual into one of two groups", *Ann. Math. Statist.*, **15**, 145-62.
1698. WALD, A. (1944), "On cumulative sums of random variables", *Ann. Math. Statist.*, **15**, 283-96.
1699. WALSH, J. E. (1946), "On the power function of the sign test for slippage of means", *Ann. Math. Statist.*, **17**, 358-62.
1700. WALSH, J. E. (1947), "Concerning the effect of intraclass correlation on certain significance tests", *Ann. Math. Statist.*, **18**, 88-96.
1701. WANG, C. M. (1947), "Methods of determining the degrees of freedom for errors", *Mem. Coll. Agric. Nat. Taiwan Univ.*, **1**.
1702. WATERS, N. F. & BYWATERS, J. H. (1943), "A study of body weights in nine different strains of White Leghorns", *Poult. Sci.*, **22**, 178-87.
1703. WAUGH, F. V. (1946), "The computation of partial correlation coefficients", *J. Amer. Statist. Ass.*, **41**, 543-6.
1704. WELCH, B. L. (1947), "The generalization of 'Student's' problem when several different population variances are involved", *Biometrika*, **34**, 28-35.
1705. WELKER, E. L. & WYND, F. L. (1943), "Influence of unknown factors on the validity of mathematical correlations of biological data", *Plant Physiol.*, **18**, 498-507.
1706. WELLMAN, R. H., THURSTON, H. W. (jun.) & WHALEY, F. R. (1947), "A method of correcting for soil variation in field tests", *Abs. in Phytopath.*, **37**, 23-4.
1707. WILKS, S. S. (1943), *Mathematical statistics*. Princeton University Press, N.J., xi+284.
1708. WILKS, S. S. (1946), "Sample criteria for testing equality of means, equality of variances and equality of covariances in a normal multivariate distribution", *Ann. Math. Statist.*, **17**, 257-81.
1709. WILLCOX, O. W. (1947), "How to make a standard yield diagram", *J. Amer. Soc. Agron.*, **39**, 74-7.
1710. WILLIAMS, C. B. (1943), "Area and number of species", *Nature, Lond.*, **152**, 264-7.
1711. WILLIAMS, C. B. (1944), "Some applications of the logarithmic series and the index of diversity to ecological problems", *J. Ecol.*, **32**, 1-44.

1712. WILLIAMS, C. B. (1946), "Yule's 'characteristic' and the 'index of diversity'", *Nature, Lond.*, **157**, 482.
1713. WILM, H. G. (1945), "Notes on analysis of experiments replicated in time", *Biometrics Bull.*, **1**, 16-20.
1714. WINSOR, C. P. (1946), "Which regression?", *Biometrics Bull.*, **2**, 101-9.
1715. WISHART, J. (1947), "The cumulants of the z and of the logarithmic z^2 and t distribution", *Biometrika*, **34**, 170-8.
1716. WOOD, E. C. (1944), "Mathematics of biological assay", *Nature*, **153**, 681-2.
1717. WOOD, E. C. (1946), "Computation of biological assays", *Nature*, **158**, 835.
1718. WOOD, E. C. & FINNEY, D. J. (1946), "Design and statistical analysis of micro-biological assays", *Quart. J. Pharm.*, **19**, 112-27.
1719. WOLFOWITZ, J. (1944), "Asymptotic distribution of runs up and down", *Ann. Math. Statist.*, **15**, 163-72.
1720. WRIGHT, S. (1943), "Isolation by distance", *Genetics*, **28**, 114-37.
1721. YATES, F. (1943), "Methods and purposes of agricultural surveys", *J. R. Soc. Arts.*, **91**, 367-79.
1722. YATES, F. (1946), "A review of recent statistical developments in sampling and sampling surveys", *J. R. Statist. Soc.*, **109**, 12.
1723. YATES, F. (1947), "Technique of the analysis of variance", *Nature, Lond.*, **160**, 472-3.
1724. YATES, F. (1947), "Analysis of data from all possible reciprocal crosses between a set of parental lines", *Heredity*, **1**, 287-301.

3. FORESTRY. D. J. FINNEY and G. G. K. SETTEN.

1725. AGUADO SMOLINSKI, J. (1947), "An example of the application of mathematical statistics to forest yield", *Inst. for. Invest. Exp. Madrid*, **18**.
1726. ANDERSON, H. W. (1947), "Soil freezing and thawing as related to some vegetation, climatic and soil variables", *J. For.*, **45**, 94-101.
1727. AUER, C. (1946), "Statistical investigation of the early growth of Larches of different provenance in the instructional forest of the Swiss Federal Technical College", *Schweiz. Zeit. Forstwesen*, **97**, 224-43.
1728. BARTON, W. W. & STOTT, C. B. (1946), "Simplified guide to intensity of cruise", *J. For.*, **44**, 750-4.
1729. BICKERSTAFF, A. (1947), "The measurement of growth on forest areas by means of recurrent line plot surveys", *For. Chron.*, **23**, 36-43.
1730. BICKERSTAFF, A. (1947), "One fifth acre versus one tenth acre plots in sampling immature stands", *Silvicultural Res. Note, Forest Service, Canada*, **83**.
1731. BICKERSTAFF, A. (1947), "Sampling efficiency in line plot survey on Riding Mountain research area", *Silvicultural Res. Note, Forest Service, Canada*, **84**.
1732. BISTRUP, C. (1944), "Approximate calculation of the standard deviation", *Dansk. Skovforen. Tidsskr.*, **29**, 166-8.
1733. BLYTHE, R. H. (1945), "The economics of sample size applied to the scaling of saw logs", *Biometrics*, **1**, 67-70.
1734. BRASNETT, N. V. (1946) "The efficiency of enumerations: A review", *Emp. For. Rev.*, **25**, 42-6.
1735. CHOW, K. Y. (1946), "A comparative study of the structure and chemical composition of tension wood and normal wood in beech", *Forestry*, **20**, 62-77.
1736. CORTES, R. T. & HAMBANANDA, P. (1947), "Fiber length of Anilau (*Columbia serratifolia*), Hinalaumo (*Mallotus ricinoides*), and Kupang (*Parkia javanica*)", *Philippine Jour. For.*, **5**, 50-70.
1737. DAY, W. R. (1946), "On the effect of changes in elevation, aspect, slope and depth of free-rooting material on the growth of European larch, Japanese larch, Sitka spruce, and Scots pine in Mynydd Dhu Forest", *Forestry*, **20**, 7-20.
1738. EGLER, F. E. (1944), "Some statistics of *Achras zapota* leaves, British Honduras", *Bull. Torrey Bot. Club*, **71**, 235-45.
1739. EKLUND, B. (1942), "A study of variations in annual growth rings at Malingsbo", *Svenska Skogs. Foren. Tidsskr.*, **40**, 233-310.
1740. FAUSTINO, D. G. (1947), "Variation of the specific gravity of Bagtikan (*Parashorea plicata*) from nine provinces of the Philippines", *Phil. Jour. For.*, **5**, 7-21.
1741. FINNEY, D. J. (1947), "Volume estimation of standing timber by sampling", *Forestry*, **21**, 179-203.
1742. FOGH, I. F. (1943) "Sampling methods in log scaling", *For. Chron.*, **19**, 127-38.
1743. GEVORKIANTZ, S. R. (1944), "Measuring stand normality", *J. For.*, **42**, 503-8.
1744. GEVORKIANTZ, S. R. & OCHSNER, H. E. (1943), "A method of sample scaling", *J. For.*, **41**, 436-9.
1745. GRIFFITH, A. L. (1945), "The efficiency of enumerations. I. The problem", *For. Leaflet. Dehra Dun*, **83**.
1746. GRIFFITH, A. L. (1945), "The efficiency of enumerations. II. Madras tropical wet evergreen forest. III. Typical calculations.", *For. Leaflet. Dehra Dun*, **84**.
1747. GRIFFITH, A. L. (1945), "The efficiency of enumerations. IV. Madras moist mixed deciduous forest", *For. Leaflet. Dehra Dun*, **85**.
1748. GRIFFITH, A. L. (1945), "The efficiency of enumerations. V. Upper Assam tropical evergreen forest. VI. Typical calculations", *For. Leaflet. Dehra Dun*, **86**.
1749. GRIFFITH, A. L. (1945), "The efficiency of enumerations. VII. The distribution of the volume figures", *For. Leaflet. Dehra Dun*, **87**.
1750. GRIFFITH, A. L. (1945), "The efficiency of enumerations. VIII. Chir (*Pinus longifolia*) forest in the Punjab and United Provinces", *For. Leaflet. Dehra Dun*, **88**.
1751. GRIFFITH, A. L. (1945), "The efficiency of enumerations. IX. The distribution of the volume figures (contd.)", *For. Leaflet. Dehra Dun*, **89**.

1951]

1752. GRIFFITH, A. L. (1946), "The efficiency of enumerations. X. Hill sal (*Shorea robusta*) forest in the United Provinces", *For. Leaflet Dehra Dun*, 90.
1753. GRIFFITH, A. L. (1946), "The efficiency of enumerations. XI. The distribution of the volume figures (contd.)", *For. Leaflet Dehra Dun*, 91.
1754. GRIFFITH, A. L. (1946), "The efficiency of enumerations. XII. One species in a mixed forest (Teak in a Madras moist deciduous forest). XIII. Confirmation of the chir (*Pinus longifolia*) and sal (*Shorea robusta*) data. XIV. Summary of indications", *For. Leaflet Dehra Dun*, 93.
1755. GRIFFITH, A. L. (1947), "The efficiency of enumerations. XV. Sal (*Shorea robusta*) forest in Dehra Dun division of the United Provinces", *For. Leaflet Dehra Dun*, 96.
1756. GRIFFITH, A. L. (1947), "The efficiency of enumerations", *Indian For.*, 73, 102-7.
1757. GRIFFITH, A. L. (1947), "The efficiency of enumerations", *Emp. For. Rev.*, 26, 105.
1758. HASEL, A. A. (1942), "Estimation of volume in timber stands by strip sampling", *Ann. Math. Statist.*, 13, 179-206.
1759. HASEL, A. A. (1946), "Logging cost as related to tree size and intensity of cutting in ponderosa pine", *J. For.*, 44, 552-60.
1760. HERRICK, A. M. (1944), "Multiple correlation in predicting the growth of many-aged oak-hickory stands", *J. For.*, 42, 812-7.
1761. HERRICK, A. M. (1945), "A numerical evaluation of stand structure", *J. For.*, 43, 891-9.
1762. HOLMSGAARD, E. (1945), "Analysis of tree-ring data from Central Jutland", *Dansk. Skogforen. Tidsskr.*, 31, 129-73.
1763. HUMMEL, F. C. (1947), "The Bowmont Norway Spruce sample plots (1930-45) (*Picea abies*, Karst.)", *Forestry*, 21, 30-42.
1764. HUTCHINSON, A. H. & KNAPP, F. M. (1946), "Random sampling, planned sampling and selective sampling: as applied to forest ecology and silviculture", *Trans. Roy. Soc. Canada*, 40.
1765. JOHNSON, F. A. (1943), "A statistical study of sampling methods for tree nursery inventories", *J. For.*, 41, 674-9.
1766. KRAMER, P. R. & STURGEON, E. E. (1942), "Transect method of estimating forest area from aerial photograph index sheets", *J. For.*, 40, 693-6.
1767. LEXEN, B. (1947), "The determination of net volume by sample tree measuring", *J. For.*, 45, 21-32.
1768. LISSDANIELS, O. M. (1947), "The size and spacing of sample plots in strip surveys", *Svenska Skogsforskn. Tidsskr.*, 45, 217-45.
1769. LOOMIS, R. D. (1946), "Accuracy in timber estimating", *For. Chron.*, 22, 201-2.
1770. LUNT, H. A. (1946), "Effect of fertiliser treatment on fieldplanted spruce", *Proc. Amer. Soc. Soil. Sci.*, 10, 406-9.
1771. MATERN, B. (1947), "Methods of estimating the accuracy of line and sample plot surveys", *Medd. Skogsforskningsinst.*, 36 (1), 1-138.
1772. MEYER, H. A. (1943), "Accuracy of growth prediction for short periods. With comments by H. H. Chapman and W. H. Meyer", *J. For.*, 41, 376-80.
1773. MEYER, W. H. (1945), "Volume-diameter ratios as a general basis for board-foot volume tables", *J. For.*, 43, 49-55.
1774. MICHAELLOFF, I. (1943), "Numerical procedure for working out curves for stand height", *Forst-Wissen. Centralblatt*, 65, 273-9.
1775. MICHAELLOFF, I. (1944), "On the accuracy of formulae for sectional volume determination", *Forst-Wissen. Centralblatt*, 2, 120-5.
1776. MUNGER, T. T. (1945), "Sample scaling by trees", *For. Res. Note Pac. N.W. For. Exp. Sta.*, 33, 12-3.
1777. NÄSLUND, M. (1945), "The number of sample trees and the accuracy of the cubic volume in forest estimation by stem counting", *Medd. Skogsforsöksanst.*, 34, 285-308.
1778. NIEDERHOF, C. H. & DUNFORD, E. G. (1942), "The effect of openings in young lodgepole pine forest on the storage and melting of snow", *J. For.*, 30, 802-4.
1779. NIEDERHOF, C. H. & WILM, H. G. (1943), "The effect of cutting mature lodgepole pine stands on rainfall interception", *J. For.*, 41, 57-61.
1780. ORDING, A. (1941), "Annual ring analyses of spruce and pine", *Medd. Skogforsöksvesen*, 7, 101-354.
1781. OSBORNE, J. G. (1942), "Sampling errors of systematic and random surveys of cover-type areas", *J. Amer. Statist. Ass.*, 37, 256-64.
1782. PROUDFOOT, M. J. (1942), "Sampling with transverse traverse lines", *J. Amer. Statist. Ass.*, 37, 265-70.
1783. RICHMOND, H. A. & LEJEUNE, R. R. (1945), "The deterioration of fire-killed spruce by wood-boring insects in northern Saskatchewan", *For. Chron.*, 21, 168-92.
1784. SCHUMACHER, F. X. (1945), "Statistical methods in forestry", *Biometrics Bull.*, 1, 29-32.
1785. SCHUMACHER, F. X. (1946), "Stacked and solid volume of south-eastern pulpwood", *J. For.*, 44, 579-82.
1786. SCHUMACHER, F. X. (1946), "Volume-weight ratios of pine logs in the Virginia-North Carolina Coastal Plain", *J. For.*, 44, 583-6.
1787. SCHUMACHER, F. X. & YOUNG, H. E. (1943), "Empirical log rules according to species, groups, and lumber grades", *J. For.*, 41, 511-8.
1788. SMITH, H. F. (1947), "Use of hydrometers to estimate dry rubber content of latex", *J. Rubber Res. Inst. Malaya*, 12, 47-61.
1789. SOULOUMIAC (1947), "The application of statistical methods to the construction of a volume table", *Rev. Eaux. For.*, 85, 649-67.
1790. STOFFELS, A. (1944), "The accuracy of measurements with Weise's hypsometer", *Ned. Boschb. Tijdschr.*, 17, 201-5.

1791. STOFFELS, A. (1947), "Determination of stand volume by measurement of two sample trees", *Ned. Boschb. Tijdschr.*, **19**, 228-35.
 1792. THOMPSON, A. P. (1945), "A sampling approach to New Zealand timber cruising problems", *New Zealand Journal of Forestry*, **5**, 103-17.
 1793. WAKELEY, P. C. (1944), "Geographic source of loblolly pine seed", *J. For.*, **42**, 23-32.
4. GENETICS. C. A. B. SMITH.
1794. BATEMAN, A. J. (1947), "Contamination in seed crops: III. Relation with isolation distance", *Heredity*, **1**, 303-35.
 1795. BEERS, C. V. & SHULL, W. G. (1943), "Hemophilia, heredity and treatment", *Genet.*, **28**, 70.
 1796. BERKSON, J. (1943), "Experience with tests of significance; a reply to Professor R. A. Fisher", *J. Amer. Statist. Ass.*, **38**, 242-6.
 1797. BUZZATI-TRAVERSO, A. & CAVALLI, L. L. (1945), "Fenotipie costituzione genetica di una popolazione di *Drosophila melanogaster*", *Mem. d'Ist. Ital. Idrobiol.*, "Dott. Marco de Marchi", **2**, 219-51.
 1798. BUZZATI-TRAVERSO, A. & CAVALLI, L. L., DI MODRONE, N. V. (1947), "Volume d'urto nelle fasi S e R di *Escherichia coli*", *Riv. di Radiol.*, **2**, 43-53.
 1799. CATCHESIDE, D. G. (1945), "Effect of ionizing radiation on chromosomes", *Biol. Rev. Camb. Phil. Soc.*, **20**, 14-28.
 1800. CAVALLI, L. L. (1945), "Alcuni problemi della analisi biometrica di popolazioni naturali", *Mem. d'Ist. Ital. Idrobiol.*, "Dott. Marco de Marchi", **2**, 301-23.
 1801. DAHLBERG, G. (1949), "A new method for determining the mutation frequency in man", *Proc. 8th Internat. Cong. Genet.*, 555-6.
 1802. DEMING, W. E. (1945), "On training in sampling", *J. Amer. Statist. Ass.*, **40**, 307-16.
 1803. DOBZHANSKY, TH. & WRIGHT, S. (1943), "Genetics of natural populations: X. Dispersion rates in *Drosophila pseudoobscura*", *Genet.*, **28**, 304-40.
 1804. FINNEY, D. J. (1943), "The detection of linkage: VII. Combination of data from matings of known and unknown phase", *Ann. Eugen. Lond.*, **12**, 31-43.
 1805. FISHER, R. A. (1944), "Allowance for double reduction in the calculation of phenotype frequencies with polysomic inheritance", *Ann. Eugen. Lond.*, **12**, 169-71.
 1806. FISHER, R. A. (1946), "The fitting of gene frequencies to data on rhesus reactions", *Ann. Eugen. Lond.*, **13**, 150-5.
 1807. FISHER, R. A. (1947), "Note on the calculation of the frequencies of rhesus allelomorphs", *Ann. Eugen. Lond.*, **13**, 223-4.
 1808. FISHER, R. A. (1947), "The theory of linkage in polysomic inheritance", *Phil. Trans. Roy. Soc., B.*, **233**, 55-82.
 1809. HALDANE, J. B. S. (1942), "The selective elimination of silver foxes in eastern Canada", *J. Genet.*, **44**, 296-394.
 1810. HALDANE, J. B. S. (1946), "The cumulants of the distributions of Fisher's ' u_{11} ' and ' u_{21} ' scores used in the detection and estimation of linkage in man", *Ann. Eugen. Lond.*, **13**, 122-34.
 1811. HALDANE, J. B. S. (1946), "The interaction of nature and nurture", *Ann. Eugen. Lond.*, **13**, 197-205.
 1812. HALDANE, J. B. S. (1947), "The dysgenic effect of induced recessive mutations", *Ann. Eugen. Lond.*, **14**, 35-43.
 1813. HALDANE, J. B. S. (1947), "The mutation rate of the gene for haemophilia and its segregation ratio in males and females", *Ann. Eugen. Lond.*, **13**, 262-71.
 1814. HALDANE, J. B. S. & LEA, D. E. (1947), "A mathematical theory of chromosomal rearrangements", *J. Genet.*, **48**, 1-10.
 1815. HALDANE, J. B. S. & SMITH, C. A. B. (1947), "A new estimate of the linkage between the genes for colour-blindness and haemophilia in man", *Ann. Eugen. Lond.*, **14**, 10-31.
 1816. HARRIS, H. (1946), "The inheritance of premature baldness in man", *Ann. Eugen. Lond.*, **13**, 172-81.
 1817. HAZEL, L. N. (1943), "The genetic basis for constructing selection indices", *Genet.*, **28**, 476-90.
 1818. HULL, F. H. (1947), "Theoretical regression of F_N on homozygous parents with additive or complementary gene action", *Genet.*, **32**, 91.
 1819. KALMUS, H., with appendix by SMITH, C. A. B. (1947), "The incidence of placenta praevia and antepartum haemorrhage according to maternal age and parity", *Ann. Eugen. Lond.*, **13**, 283-90.
 1820. KLOEPFER, H. W. (1946), "An investigation of 171 possible linkage relationships in man", *Ann. Eugen. Lond.*, **13**, 35-71.
 1821. KOSAMBI, D. D. (1944), "Map distances from recombination values", *Ann. Eugen. Lond.*, **12**, 172-5.
 1822. KOSAMBI, D. D. (1947), "An extension of the least-squares method for statistical estimation", *Ann. Eugen. Lond.*, **13**, 257-61.
 1823. KRAMER, H. H. & BURNHAM, C. R. (1947), "Methods of combining linkage intensity values from backcross F_2 and F_3 genetic data", *Genet.*, **32**, 379-90.
 1824. LEA, D. E. & CATCHESIDE, D. G. (1942), "Chromosome aberrations in *Tradescantia*", *J. Genet.*, **44**, 216-45.
 1825. LEVINE, H. & DOBZHANSKY, TH. (1945), "Experiments on sexual isolation in *Drosophila*. V. The effect of varying proportions of *D. pseudoobscura* and *D. persimilis* on the frequency of isolation", *Proc. Nat. Acad. Sci.*, **31**, 274-81.
 1826. LOTKA, A. J. (1943), "Some reflections—statistical and other—on a non-material universe", *J. Amer. Statist. Ass.*, **38**, 1-15.

1951]

1827. LURIA, S. E. & DELBRÜCK, M. (1943), "Mutations of bacteria from virus sensitivity to virus resistance", *Genet.*, **28**, 491-511.
1828. MATHER, K. (1942), "The balance of polygenic combinations", *J. Genet.*, **43**, 309-36.
1829. MATHER, K. (1943), "Polygenic inheritance and natural selection", *Biol. Rev. Camb. Phil. Soc.*, **18**, 32-64.
1830. MATHER, K. (1944), "The calculation of sister-reunion frequency. (Appendix to paper by Darlington and La Cour.)", *J. Genet.*, **46**, 252-63.
1831. MATHER, K. & BEALE, G. H. (1942), "The calculation and precision of linkage values from tetrad analysis", *J. Genet.*, **43**, 1-30.
1832. PANSE, V. G. (1946), "An application of the discriminant function for selection in poultry", *J. Genet.*, **47**, 242-8.
1833. PENROSE, L. S. (1946), "A further note on the sub-pair linkage method", *Ann. Eugen. Lond.*, **13**, 25-9.
1834. PENROSE, L. S. (1946), "On the familial appearances of maternal and foetal incompatibility", *Ann. Eugen. Lond.*, **13**, 141-5.
1835. PHILIP, U. (1944), "An analysis of chromosomal polymorphism in two species of *Chironomus*", *J. Genet.*, **44**, 129-42.
1836. RIMMER, F. & HENDERSON, M. T. (1943), "Linkage studies in barley", *Genet.*, **28**, 419-40.
1837. SPENCER, W. P. (1942), "Are natural mutations in wild *Drosophila* distributed in a Poisson series? (Abstract)", *Genet.*, **27**, 171.
1838. STANTON, R. G. (1946), "Filial and fraternal correlations in successive generations", *Ann. Eugen. Lond.*, **13**, 18-24.
1839. STEVENS, W. L. (1942), "Accuracy of mutation rates", *J. Genet.*, **43**, 310-7.
1840. WRIGHT, S. (1942), "Statistical genetics and evolution", *Bull. Amer. Math. Soc.*, **48**, 233-46.
1841. WRIGHT, S. (1943), "Isolation by distance", *Genet.*, **28**, 114-38.
1842. WRIGHT, S. (1943), "An analysis of local variability of flower colour of *Linanthus parryae*", *Genet.*, **28**, 139-56.
1843. WRIGHT, S. (1945), "The differential equation of the distribution of gene frequencies", *Proc. Nat. Acad. Sci.*, **31**, 382-9.
1844. WRIGHT, S. (1946), "Isolation by distance under diverse systems of mating", *Genet.*, **31**, 39-59.
1845. WRIGHT, S. & DOBZHANSKY, TH. (1946), "Genetics of natural populations. XII. Experimental reproduction of some of the changes caused by natural selection in certain populations of *Drosophila pseudoobscura*", *Genet.*, **31**, 125-56.
1846. YATES, F. (1947), "Analysis of data from all possible reciprocal crosses between a set of parental lines", *Heredity*, **1**, 287-301.

5. PSYCHOLOGY. B. BABINGTON SMITH.

1847. ADcock, C. J. (1946), "Simplified factor analysis", *Occup. Psychol. Lond.*, **20**, 188-98.
1848. ALEXANDER, H. W. (1946), "A general test for trend", *Psychol. Bull.*, **43**, 533-57.
1849. ANSBACHER, H. L. & MATHER, K. (1945), "Group differences in size estimation", *Psychometrika*, **10**, 37-56.
1850. BAXTER, B. (1943), "The problem of reliability in relation to factorial design", *J. Gen. Psychol.*, **29**, 157-61.
1851. BEALL, G. (1945), "Approximate methods in calculating discriminant functions", *Psychometrika*, **10**, 205-17.
1852. BERNYER, G. (1943), "L'Estimation des facteurs psychologiques par la regression", *L'Année Psychologique*, **43-44**, 299-322.
1853. BROGDEN, H. E. (1944), "On the estimation of the changes in correlation and regression constants due to selection on a single given variable", *J. Educ. Psychol.*, **35**, 484-92.
1854. BROGDEN, H. E. (1946), "An approach to the problem of differential prediction", *Psychometrika*, **11**, 139-54.
1855. BROGDEN, H. E. (1946), "Variation in test validity with variation in the distribution of item difficulties, number of items, and degree of their intercorrelation", *Psychometrika*, **11**, 197-214.
1856. BURT, C. (1943), "Validating tests for personnel selection", *Brit. J. Psychol.*, **34**, 1-19.
1857. BURT, C. (1944), "Statistical problems in the evaluation of army tests", *Psychometrika*, **9**, 219-35.
1858. BURT, C. (1944), "Mental abilities and mental factors", *Brit. J. Educ. Psychol.*, **14**, 85-94.
1859. BURT, C. (1945), "The reliability of teachers' assessments of their pupils", *Brit. J. Educ. Psychol.*, **15**, 80-92.
1860. CARLSON, H. B. (1945), "A simple orthogonal multiple factor approximation procedure", *Psychometrika*, **10**, 283-301.
1861. CARROLL, J. B. (1945), "The effect of difficulty and chance success on correlations between items or between tests", *Psychometrika*, **10**, 1-19.
1862. CARTWRIGHT, W. & FESTINGER, L. (1943), "A quantitative theory of decision", *Psychol. Review*, **50**, 595-621.
1863. CATTELL, R. (1944), "A note on correlation clusters and cluster search methods", *Psychometrika*, **9**, 169-84.
1864. CATTELL, R. B. (1944), "Parallel proportional profiles and other principles for determining the choice of factors by rotation", *Psychometrika*, **9**, 267-83.
1865. CATTELL, R. B. (1945), "The description of personality: principles and findings in a factor analysis", *Amer. J. Psychol.*, **58**, 69-90.

1866. CATTELL, R. B. (1946), *Description and Measurement of Personality*. Yonkers: World Book Company, xv+602 pp.
1867. CATTELL, R. B. (1946), "Simple structure in relation to some alternative factorizations of the personality sphere", *J. Gen. Psychol.*, **35**, 225-38.
1868. CHAPPLE, E. D. (1942), "The measurement of interpersonal behaviour", *Trans. N. Y. Acad. Sci.*, **4**, 222-3.
1869. CHILD, I. L. (1946), "A note on Grant's 'New Statistical Criteria for Learning and Problem Solution'", *Psychol. Bull.*, **43**, 558-61.
1870. COLLIAS, N. E. (1943), "Statistical analysis of factors which make for success in initial encounters between hens", *Amer. Nat.*, **77**, 519-38.
1871. CRONBACH, L. J. (1943), "Note on the reliability of ratio scores", *Educ. Psychol. Measmt.*, **3**, 67-70.
1872. DAVIS, F. B. (1945), "The reliability of component scores", *Psychometrika*, **10**, 57-60.
1873. DELAFORTE, P. (1939), "A method of correlation analysis", *C. R. Acad. Sci. Paris*, **208**, 1960-3.
1874. DOVE, W. F. (1943), "The relative nature of human preference: with an example in the palatability of different varieties of sweet corn", *J. Comp. Psychol.*, **35**, 219-26.
1875. EDGERTON, H. A. & THOMSON, K. F. (1942), "Test scores examined with the Lexis ratio", *Psychometrika*, **7**, 281-8.
1876. EDWARDS, A. L. & KENNEY, K. C. (1946), "A comparison of the Thurstone and Lickert techniques of attitude scale construction", *J. Appl. Psychol.*, **30**, 72-83.
1877. FARNSWORTH, P. R. (1945), "Attitude scale construction and the method of equal appearing intervals", *J. Psychol.*, **20**, 245-8.
1878. FERGUSON, G. A. (1942), "Item selection by the constant process", *Psychometrika*, **7**, 19-29.
1879. FESTINGER, L. (1943), "A statistical test for means of samples from skew populations", *Psychometrika*, **8**, 205-10.
1880. FESTINGER, L. (1943), "Studies in decision. II. An Empirical test of a quantitative theory of decision", *J. Exp. Psychol.*, **32**, 411-23.
1881. FESTINGER, L. (1946), "The significance of difference between means without reference to the frequency distribution function", *Psychometrika*, **11**, 97-105.
1882. FINNEY, D. J. (1944), "The application of probit analysis to the results of mental tests", *Psychometrika*, **9**, 31-40.
1883. FISKE, D. W. & DUNLAP, J. W. (1945), "A graphical test for the significance of differences between frequencies from different samples", *Psychometrika*, **10**, 225-9.
1884. FULCHER, J. S. & ZUBIN, J. (1942), "The item analyzer: a mechanical device for treating the four fold table in large samples", *J. Appl. Psychol.*, **26**, 511-23.
1885. GARRETT, H. E. (1942), "The representativeness of a sample", *Amer. J. Psychol.*, **55**, 580-1.
1886. GARRETT, H. E. (1943), "The discriminant function and its use in psychology", *Psychometrika*, **8**, 65-79.
1887. GARRETT, H. E. & ZUBIN, J. (1943), "Analysis of variance in psychological research", *Psychol. Bull.*, **40**, 233-67.
1888. GRANNEBERG, R. (1946), "Comparison of controlled and non-controlled characteristics of two samples of the same population", *Amer. Psychologist*, **1**, 453.
1889. GRANT, D. A. (1944), "On 'The analysis of variance in psychological research'", *Psychol. Bull.*, **41**, 158-66.
1890. GRANT, D. A. (1946), "New statistical criteria for experiments involving repeated trials", *Amer. Psychologist*, **1**, 463-4.
1891. GRANT, D. A. (1946), "New statistical criteria for learning and problem solution in experiments involving repeated trials", *Psychol. Bull.*, **43**, 272-82.
1892. GREENWOOD, J. A. (1942), "The role mathematics has played in E.S.P. research", *J. Parapsychol.*, **6**, 268-83.
1893. GREENWOOD, J. A. (1943), "On the evaluation of differences of success ratios from binomial populations", *J. Parapsychol.*, **7**, 277-80.
1894. GREENWOOD, J. A. (1943), "A preferential matching problem", *Psychometrika*, **8**, 185-91.
1895. GREVILLE, T. N. E. (1943), "Frequency distributions of ESP scores for certain selected call-patterns", *J. Parapsychol.*, **7**, 272-6.
1896. GROSSMAN, D. (1944), "Technique for weighting of choices and items on I.B.M. scoring machines", *Psychometrika*, **9**, 101-4.
1897. GROSSNICKLE, L. T. (1942), "The scaling of test scores by the method of paired comparisons", *Psychometrika*, **7**, 43-64.
1898. GULLIKSEN, H. (1942), "An analysis of learning data which distinguishes between initial preference and learning ability", *Psychometrika*, **7**, 171-94.
1899. GULLIKSEN, H. (1945), "The relation of item difficulty and inter-item correlation to test variance and reliability", *Psychometrika*, **10**, 79-91.
1900. GULLIKSEN, H. (1946), "Paired comparisons and the logic of measurement", *Psychol. Rev.*, **53**, 199-213.
1901. GUTTMAN, L. (1945), "A basis for analyzing test-retest reliability", *Psychometrika*, **10**, 255-82.
1902. GUTTMAN, L. (1946), "The test-retest reliability of qualitative data", *Psychometrika*, **11**, 81-95.
1903. GUTTMAN, L. & COHEN, J. (1943), "Multiple rectilinear prediction and the resolution into components: II", *Psychometrika*, **8**, 169-83.
1904. HAYES, S. P. (jun.) (1943), "Tables of the standard error of tetrachoric correlation coefficient", *Psychometrika*, **8**, 193-203.

1905. HAYES, S. P. (jun.) (1946), "Diagrams for computing tetrachoric correlation coefficients from percentage differences", *Psychometrika*, **11**, 163-72.
1906. HEESE, K. W. (1942), "A general factor in improvement with practice", *Psychometrika*, **7**, 213-23.
1907. HENRY, F. M. (1945), "Some neglected aspects of test efficiency", *Psychol. Bull.*, **42**, 537.
1908. HOLZINGER, K. J. (1944), "Factoring test scores and implications for the method of averages", *Psychometrika*, **9**, 155-68.
1909. HOLZINGER, K. J. (1944), "A simple method of factor analysis", *Psychometrika*, **9**, 257-62.
1910. HOLZINGER, K. J. (1945), "Interpretation of second order factors", *Psychometrika*, **10**, 21-5.
1911. HOLZINGER, K. J. (1946), "A comparison of the principal axis and centroid factor", *J. Educ. Psychol.*, **37**, 449-72.
1912. HORN, D. (1942), "A correction for the effect of tied ranks on the value of the rank difference correlation coefficient", *J. Educ. Psychol.*, **33**, 686-90.
1913. HOYT, C. J. (1945), "Testing linear hypotheses illustrated by a simple example in correlation", *Psychometrika*, **10**, 199-204.
1914. HSU, E. H. (1946), "On the correlation between a variable and its super-factor", *J. Psychol.*, **22**, 89-92.
1915. HSU, E. H. & SHERMAN, M. (1946), "The factorial analysis of the electroencephalogram", *J. Psychol.*, **21**, 189-96.
1916. JANIS, I. L. & FADNER, R. H. (1943), "A coefficient of imbalance for content analysis", *Psychometrika*, **8**, 105-19.
1917. JARRETT, R. F. (1945), "On the permissible coarseness of grouping" *J. Educ. Psychol.*, **36**, 385-95.
1918. JARVIK, M. E. (1946), "Probability discrimination and the gambler's fallacy in guessing", *Amer. Psychologist*, **1**, 453-4.
1919. JASPEN, N. (1946), "Serial correlation", *Psychometrika*, **11**, 23-30.
1920. JOHNSON, H. G. (1944), "An empirical study of the influence of errors of measurement upon correlation", *Amer. J. Psychol.*, **57**, 521-36.
1921. JOHNSON, H. M. (1944), "A useful interpretation of Pearsonian r in 2×2 contingency tables", *Amer. J. Psychol.*, **57**, 236-42.
1922. JOHNSON, H. M. (1943), "Index-numerology and measures of impairment", *Amer. J. Psychol.*, **56**, 551-8.
1923. JOHNSON, H. M. (1945), "Maximal selectivity, correctivity and correlation obtainable in 2×2 contingency-tables", *Amer. J. Psychol.*, **58**, 65-8.
1924. JOHNSON, H. M. (1942), "General rules for predicting the selectivity of a test when the standardizing population and the parent population are not necessarily homogeneous", *Psychol. Bull.*, **39**, 577.
1925. JOHNSON, P. O. & TSAO, F. (1944), "Factorial design in the determination of differential limen values", *Psychometrika*, **9**, 107-44.
1926. JOHNSON, P. O. & TSAO, F. (1945), "Factorial design and covariance in the study of individual educational development", *Psychometrika*, **10**, 133-62.
1927. KAITZ, H. B. (1945), "A note on reliability", *Psychometrika*, **10**, 127-31.
1928. KATZOFF, E. T. (1942), "The measurement of conformity", *Psychometrika*, **7**, 31-42.
1929. KELLEY, T. L. (1944), "A variance-ratio test of the uniqueness of principal-axis components as they exist at any stage of the Kelley iterative process for their determination", *Psychometrika*, **9**, 199-200.
1930. LANDAHL, H. D. (1945), "A note on the mathematical biophysics of central excitation and inhibition", *Bull. Math. Biophys.*, **7**, 219-21.
1931. LANDAHL, H. D., MCCULLOCH, W. S. & PITTS, W. (1943), "A statistical consequence of the logical calculus of nervous nets", *Bull. Math. Biophys.*, **5**, 135-7.
1932. LAWLEY, D. N. (1942), "Further investigations in factor estimates", *Proc. R. Soc. Edin.*, **61**, 176-85.
1933. LAWLEY, D. N. (1943), "The application of the maximum likelihood method to factor analysis", *Brit. J. Psychol.*, **33**, 172-5.
1934. LAWLEY, D. N. (1944), "The factorial analysis of multiple item tests", *Proc. R. Soc. Edin.*, **62-A**, 74-82.
1935. LETTVIN, J. Y. & PITTS, W. (1943), "A mathematical theory of the affective psychoses", *Bull. Math. Biophys.*, **5**, 139-48.
1936. LORD, F. M. (1944), "Alignment chart for calculating the fourfold point correlation coefficient", *Psychometrika*, **9**, 41-2.
1937. LORR, M. (1944), "Interrelationships of number-correct and limen scores for an amount-limit test", *Psychometrika*, **9**, 17-30.
1938. MCCULLOCH, W. S. (1945), "A heterarchy of values determined by the topology of nervous nets", *Bull. Math. Biophys.*, **7**, 89-93.
1939. MCCULLOCH, W. S. & PITTS, W. (1943), "A logical calculus of the ideas immanent in nervous activity", *Bull. Math. Biophys.*, **5**, 115-33.
1940. MCNEMAR, Q. (1942), "In reply to Garrett", *Amer. J. Psychol.*, **55**, 581-2.
1941. MCNEMAR, Q. (1945), "The mode of operation of suppressant variables", *Amer. J. Psychol.*, **58**, 554-5.
1942. MANN, H. B. (1945), "On a problem of estimation occurring in public opinion polls", *Ann. Math. Statist.*, **16**, 85-90.
1943. MANN, H. B. (1946), "Correction to the paper 'On a problem of estimation occurring in public opinion polls'", *Ann. Math. Statist.*, **17**, 87-8.

1944. MEEHL, P. E. (1945), "A simple algebraic development of Horst's suppressor variables", *Amer. J. Psychol.*, **58**, 550-4.
1945. MILLER, G. A. & GERNER, W. R. (1944), "Effect of random presentation on the psychometric function: implications for a quantal theory of discrimination", *Amer. J. Psychol.*, **57**, 451-67.
1946. MORGAN, C. T. (1945), "The statistical treatment of hoarding data", *J. Comp. Psychol.*, **38**, 247-56.
1947. MOSIER, C. I. (1943), "On the reliability of a weighted composite", *Psychometrika*, **8**, 161-8.
1948. NIXON, H. K. (1946), "Internal evidence of validity of a rating scale", *J. of Psychol.*, **22**, 97-115.
1949. PASCHAL, F. C. (1942), "On the weighting of broad categories", *Psychol. Bull.*, **39**, 576-7.
1950. PEATMAN, J. G. & SCHAFER, R. (1942), "A table of random numbers from selective service numbers", *J. Psychol.*, **14**, 295-305.
1951. PEEL, E. A. (1946), "A new method for analyzing aesthetic preferences: some theoretical considerations", *Psychometrika*, **11**, 129-37.
1952. PENROSE, L. S. (1946), "The elementary statistics of majority voting", *J. R. Statist. Soc.*, **109**, 53-7.
1953. PETERS, C. C. (1944), "Interaction in analysis of variance interpreted as intercorrelation", *Psychol. Bull.*, **41**, 287-99.
1954. PRESTON, M. G. & ZEID, P. M. (1943), "Observations on sequences of choices made at five successive choice points", *J. Exp. Psychol.*, **32**, 275-90.
1955. POSTMAN, L. & BRUNER, J. S. (1946), "The reliability of constant errors in psychophysical measurements", *J. Psychol.*, **21**, 293-9.
1956. RASHEVSKY, N. (1942), "Further studies on the mathematical theory of interaction of individuals in a social group", *Psychometrika*, **7**, 225-32.
1957. RASHEVSKY, N. (1942), "Contributions to the mathematical theory of human relations. V", *Psychometrika*, **7**, 117-34.
1958. RASHEVSKY, N. (1943), "Contributions to the mathematical theory of human relations: VI. Periodic fluctuations in the behaviour of social P", *Psychometrika*, **8**, 81-5.
1959. RASHEVSKY, N. (1943), "Contributions to the theory of human relations: VII. Outline of a mathematical theory of the size of cities", *Psychometrika*, **8**, 87-90.
1960. RASHEVSKY, N. (1944), "Contributions to the mathematical theory of human relations. VIII. Size distribution of cities", *Psychometrika*, **9**, 201-15.
1961. RASHEVSKY, N. (1945), "Some remarks on the Boolean algebra of nervous nets in mathematical biophysics", *Bull. Math. Biophys.*, **7**, 203-11.
1962. RASHEVSKY, N. (1945), "A suggestion for another statistical interpretation of the fundamental equations of the mathematical biophysics of the central nervous system", *Bull. Math. Biophys.*, **7**, 223-6.
1963. RASHEVSKY, N. (1945), "A reinterpretation of the mathematical biophysics of the central nervous system in the light of neurophysiological findings", *Bull. Math. Biophys.*, **7**, 151-60.
1964. REYBURN, H. A. & TAYLOR, J. G. (1943), "On the interpretation of common factors: a criticism and a statement", *Psychometrika*, **8**, 53-64.
1965. RICHARDSON, L. F. (1946), "The number of nations on each side of a war", *J. R. Statist. Soc.*, **109**, 130-56.
1966. SADOWSKY, M. A. (1944), "Mathematical analysis in psychology of education; computation of stimulation, rapport, and instructor's driving power", *Psychometrika*, **9**, 249-56.
1967. SCOTT BLAIR, G. W. & COPPEN, F. M. V. (1943), "The estimation of firmness in soft materials", *Amer. J. Psychol.*, **56**, 234-46.
1968. SPIEGELMAN, S. & REINER, J. M. (1945), "A note on steady states and the Weber-Fechner Law", *Psychometrika*, **10**, 27-35.
1969. SUMNER, F. C. & DEHANEY, K. G. (1943), "Size and placement of intervals as influencing a Pearson product-moment correlation coefficient obtained by the scatter-diagram procedure", *J. Psychol.*, **15**, 27-30.
1970. THOMSON, G. H. (1944), "The applicability of Karl Pearson's formulae in follow-up experiments", *Brit. J. Psychol.*, **34**, 105.
1971. THORNTON, G. R. (1943), "The significance of rank difference coefficients of correlation", *Psychometrika*, **8**, 211-22.
1972. THURSTONE, L. L. (1945), "A multiple group method of factoring the correlation matrix", *Psychometrika*, **10**, 73-8.
1973. THURSTONE, L. L. (1944), "Second-order factors", *Psychometrika*, **9**, 71-100.
1974. THURSTONE, L. L. (1945), "The effects of selection in factor analysis", *Psychometrika*, **10**, 165-98.
1975. THURSTONE, L. L. (1945), "The prediction of choice", *Psychometrika*, **10**, 237-53.
1976. THURSTONE, L. L. (1946), "A single plane method of rotation", *Psychometrika*, **11**, 71-9.
1977. TUCKER, L. R. (1944), "A semi-analytical method of factorial rotation to simple structure", *Psychometrika*, **9**, 43-68.
1978. TUCKER, L. R. (1944), "The determination of successive principal components without computation of residual correlation coefficients", *Psychometrika*, **9**, 149-53.
1979. TUCKER, L. R. (1946), "Maximum validity of a test with equivalent items", *Psychometrika*, **11**, 1-13.
1980. WEICHEL, J. A. (1946), "A first-order method for estimating correlation coefficients", *Psychometrika*, **11**, 215-21.
1981. WENGER, M. A. (1946), "A factorial approach to psychophysiological relationships", *Amer. Psychologist*, **1**, 464.
1982. WHERRY, R. J. (1944), "Maximal weighting of qualitative data", *Psychometrika*, **9**, 263-6.
1983. WHERRY, R. J. (1946), "Test selection and suppressor variables", *Psychometrika*, **11**, 239-47.

1951]

1984. WHERRY, R. J. & GAYLORD, R. H. (1943), "The concept of test and item reliability in relation to factor pattern", *Psychometrika*, **8**, 247-64.
1985. WHERRY, R. J. & GAYLORD, R. H. (1944), "Factor pattern of test items and tests as a function of the correlation coefficient: content, difficulty, and constant error factors", *Psychometrika*, **9**, 237-44.
1986. WHERRY, R. J. & TAYLOR, E. K. (1946), "The relation of multiseria eta to other measures of correlation", *Psychometrika*, **11**, 155-61.
1987. ZIMMERMAN, W. S. (1946), "A simple graphical method for orthogonal rotation of axes", *Psychometrika*, **11**, 51-5.
1988. ZIPF, G. K. (1946), "The $\frac{P_1 P_2}{D}$ hypothesis: the case of railway express", *J. Psychol.*, **22**, 3-8.

6. INDUSTRY. E. D. VAN REST.

1989. ANSCOMBE, F. J. (1946), "Linear sequential rectifying inspection for controlling fraction defective", *J. R. Statist. Soc. Suppl.*, **8**, 216.
1990. ANSCOMBE, F. J., GODWIN, H. J. & PLACKETT, R. L. (1947), "Methods of deferred sentencing in testing the fraction defective of a continuous output", *J. R. Statist. Soc. Suppl.*, **9**, 198.
1991. BARNARD, G. A. (1945), "Economy in sampling", *Nature, Lond.*, **156**, 208.
1992. BARNARD, G. A. "Economy in sampling with special reference to engineering experimentation", *NRDC Appl. Math. Panel Memo. No. 30.2; Columbia Univ. Statist. Res. Group No. 182, 1944; Publ. Bd. No. 40627.*
1993. BARNARD, G. A. (1946), "Sequential tests in industrial statistics", *J. R. Statist. Soc. Suppl.*, **8**, 1.
1994. BROWN, G. W. (1947), "Tumbler mortality", *J. Amer. Statist. Ass.*, **42**, 562.
1995. BUTTERBAUGH, G. I., "A bibliography of statistical quality control", *Univ. of Washington Press*, **114**, 9 pp.
1996. CAMPBELL, W. E. (1942), "The use of statistical control in corrosion and contact resistance studies", *Trans. Electrochem., Soc.*, **81**, 377.
1997. CARPENTER, H. C. H. (1945), "Statistical quality control", *J. Inst. Actu. Stud. Soc.*, **5**, 207-17.
1998. CHURCHMAN, C. W. (1946), "Most economic sampling for chemical analysis", *Industr. Engng. Chem.*, **18**, 267-8.
1999. CHURCHMAN, C. W. & EPSTEIN, B. (1946), "Tests of increased severity", *J. Amer. Statist. Ass.*, **41**, 567.
2000. CLANCEY, V. J. (1947), "Statistical methods in chemical analysis", *Nature*, **159**, 4036.
2001. DEMING, W. E. (1943), "Opportunities in mathematical statistics, with special reference to sampling and quality control", *Science*, **97**, 209-14.
2002. DUDING, B. P. (1944), "The Industrial Applications Group of the Royal Statistical Society", *J. R. Statist. Soc.*, **107**, 60.
2003. EDWARDS, J. C. & BENNETT, W. A. (1945), "Inspection efficiency", *Proc. Inst. Mech. Eng.*, **152**, 69.
2004. EVANS, U. R. (1945), "Statistical methods in deciding the efficacy of a modification in technical procedure. The use of the t-test to chemists and engineers", *Chem. Ind. Rev.*, **64**, 106-9.
2005. FAIRFIELD, H. H. (1943), "Statistical analysis of inspection results", *Eng. J. Can.*, **26**, 492.
2006. FERRELL, E. B. (1945), "Statistical method on the development of apparatus life quality", *Elec. Eng. Trans. Sect.*, **64**, 700.
2007. FINNEY, D. J. (1947), "Application of statistical methods to food problems", *Nature*, **159**, 36-7.
2008. FOSTER, G. A. R. (1946), "Some instruments for the analysis of time series and their application to textile research", *J. R. Statist. Soc. Suppl.*, **8**, 42.
2009. FREUDENTHAL, A. M. (1946), "The statistical aspect of fatigue of materials", *Proc. Roy. Soc. A*, **187**, 416.
2010. GOTUSSO, G. (1945), "Probabilità di rottura di un filo", *Lett. Ist. lombardo Sci.*, **9**, 78, 182-90.
2011. GRIMSEY, A. H. R. (1946), "Ultimate risks in sampling inspection", *J. R. Statist. Soc. Suppl.*, **8**, 244.
2012. HARDING, E. W. (1946), "Statistical control applied to high duty iron production", *J. R. Statist. Soc. Suppl.*, **8**, 233.
2013. HERLITZ (1946), "Overlapping of welding loads", *Tekn. Tidskr.*, **76**, 226; *Sc. Abs. B*, **127**, B.
2014. HOBSON, L. S., INGLES, R. S. & McCANTES, R. P. (1945), "Application of quality control to resistance welding", *Trans. Amer. Inst. Elect. Engrs.*, **64**, 573.
2015. HOPKINS, J. W. & WEATHERBURN, M. W. (1947), "Precision of laboratory measurements of breaking strength of textiles", *Canad. J. Res.*, **F**, **25**, 264-72.
2016. HOTELLING, H. (1944), "Some improvements in weighing and other experimental techniques", *Ann. Math. Statist.*, **15**, 297.
2017. KEELING, D. B. & CISNE, L. F. (1942), "Double sampling inspection in a manufacturing plant", *Bell. Syst. Tech. J.*, **21**, 37.
2018. LAOM, M. (1946), "Inspection efficiency and sampling inspection plans", *J. Amer. Statist. Ass.*, **41**, 432.
2019. LIDWELL, O. M. (1944), "A particle size distribution function for air-borne ducts", *Nature*, **158**, 61.
2020. MACCOLL, H. G. (1944), "The statistical control of accuracy in routine analysis", *Chem. and Ind.*, **49**, 438.
2021. MANDEL, J. (1945), "Efficient statistical methods in chemistry", *Industr. Engng. Chem.*, **17**, 201-6.

2022. MARCUSE, S. (1945), "An application of the control chart method to the testing and marketing of foods", *J. Amer. Statist. Ass.*, **40**, 214.
2023. MOOD, A. M. (1943), "On the dependence of sampling inspections plans upon population distributions", *Ann. Math. Statist.*, **14**, 415.
2024. NEAL, N. R. (1945), "The application of statistical methods to the control of industrial costs", *Proc. Inst. Mech. Eng.*, **152**, 76.
2025. PAULSON, E. (1943), "A note on tolerance limits", *Ann. Math. Statist.*, **14**, 90.
2026. PEACH, P. & LITTAUER, S. B. (1946), "A note on sampling inspection", *Ann. Math. Statist.*, **17**, 81.
2027. PEEL, E. A. (1947), "A short method of calculating maximum battery reliability", *Nature*, **159**, 4050.
2028. RAPPLEYE, S. C. (1946), "A study of the delays encountered by toll operators in obtaining an idle trunk", *Bell. Syst. Tech. J.*, **25**.
2029. ROTT, N. (1946), "Über Wahrscheinlichkeitsprobleme der Garnfestigkeitsprüfung", *Schweiz. Arch. angew. Wiss. Tech.*, **12**, 93-5.
2030. SCHEFFÉ, H. (1947), "Relation of control charts to analysis of variance and chi-square tests", *J. Amer. Statist. Ass.*, **42**, 425-634.
2031. SCHROCK, E. M. (1944), "Matters of misconception concerning the quality control chart", *J. Amer. Statist. Ass.*, **39**, 325.
2032. SICHEL, H. S. (1947), "An experimental and theoretical investigation of bias error in mine sampling with special reference to narrow gold reefs", *B. Inst. Mining Metall.*, **483**, 1-41.
2033. SIMON, L. E. (1944), "The industrial lot and its sampling implications", *J. Franklin Inst.*, **237**, 359.
2034. SWAN, A. W. (1945), "Sampling schemes for qualitative inspection", *Proc. Inst. Mech. Eng.*, **152**, 81.
2035. SWANSON, C. O. (1945), "Probabilities in estimating the grade of gold deposits", *Trans. Canad. Min. Inst.*, **48**, 323-50.
2036. TAYLOR, J. J. (1945), "Statistical methods applied to insulator development and manufacture", *Trans. Amer. Inst. Elect. Engrs.*, **64**, 495.
2037. TIPPETT, L. H. C. (1946), "The control of industrial processes subject to trends in quality", *Biometrika*, **33**, 163-72.
2038. TIPPETT, L. H. C. (1944), "The efficient use of gauges in quality control", *Engineer*, **177**, 481.
2039. VILLE, J. (1944), "Statistical study of irregularities in co-axial cables. Echoes and after effects", *Bull. Soc. Franç. Elect.*, **4**, 253.
2040. VROOM, H. H. (1943), "The statistical control of quality. Application of statistical inspection in the telephone industry", *Eng. J. Can.*, **26**, 398.
2041. WILKS, S. S. (1947), "Statistical training for industry", *Industr. Engng. Chem.*, **19**, 953-55.
2042. WILSON, M. R. (1945), "Maintaining quality of small arms ammunition", *Can Metals and Met. Ind.*, **8**, 37.
2043. WISE, M. E. (1946), "Use of the negative binomial in an industrial sampling problem", *J. R. Statist. Soc. Suppl.*, **8**, 202-11.
2044. WOLFOWITZ, J. (1943), "On the theory of runs with some application to quality control", *Ann. Math. Statist.*, **14**, 280.

7. COMPUTATION P. ARMITAGE

2045. ANON. (1946-47), "Nomogram van de χ^2 -test of goodness of fit", *Statist. (Leiden)*, **1**, 107-11.
2046. BARTLETT, N. R. (1946), "A punched-card technique for computing means, standard deviations, and the product moment correlation coefficient and for listing scattergrams", *Science*, **104**, 374-5.
2047. BENJAMIN, K. (1945), "I.B.M. technique for the computation of Σx^2 and Σxy ", *Psychometrika*, **10**, 61-7.
2048. BENJAMIN, K. (1947), "Problems of multiple-punching with Hollerith machines", *J. Amer. Statist. Ass.*, **42**, 46-71.
2049. BERRY, C. E. (1945), "A criterion of convergence for the classical iterative method of solving linear simultaneous equations", *Ann. Math. Statist.*, **16**, 398-400.
2050. BLACK, B. J. & OLDS, E. B. (1946), "A punched card method for presenting, analyzing, and comparing many series of statistics for areas", *J. Amer. Statist. Ass.*, **41**, 347-55.
2051. BLISS, C. I. (1944), "A chart of the chi-square distribution", *J. Amer. Statist. Ass.*, **39**, 246-8.
2052. BOWIE, O. L. (1947), "A least-square application to relaxation methods", *J. Appl. Physics*, **18**, 830-3.
2053. BOWKER, A. H. (1947), "On the norm of a matrix", *Ann. Math. Statist.*, **18**, 285-8.
2054. BOYER, C. B. (1947), "Note on an early graph of statistical data (Huygens, 1669)", *Isis*, **37**, 148-9.
2055. BRUNER, N. & LEAVENS, D. H. (1947), "Notes on the Doolittle solution", *Econometrica*, **15**, 43.
2056. BURT, C. (1945), "Use of stereographic projection for statistical problems", *Nature, Lond.*, **156**, 338.
2057. BUSK, T. (1946), "Dot and scatter diagrams made by means of a typewriter", *J. R. Statist. Soc.*, **109**, 451-6.
2058. COCHRAN, W. G. (1946), "Use of I.B.M. equipment in an investigation of the 'truncated normal' problem", *Proc. Res. Forum, Endicott (N.Y.)*, 40-4.
2059. COMRIE, L. J. (1946), "The application of commercial calculating machines to scientific computing", *Math. Tables*, **2**, 149-59.
2060. COWDEN, D. J. (1943), "Correlation concepts and the Doolittle method", *J. Amer. Statist. Ass.*, **38**, 327-34.
2061. COX, E. G., GROSS, L. & JEFFREY, G. A. (1947), "Use of punched card tabulating machines for crystallographic Fourier syntheses", *Nature, Lond.*, **159**, 433-4.

1951]

2062. CROW, J. F. (1945), "A chart of the χ^2 and t distributions", *J. Amer. Statist. Ass.*, **40**, 376.
2063. DODD, E. L. (1942), "A transformation of Tippet random sampling numbers into numbers normally distributed", *Bol. mat., B. Aires*, **15**, 73-7.
2064. DWYER, P. S. (1944), "A matrix presentation of least squares and correlation theory with matrix justification of improved methods of solution", *Ann. Math. Statist.*, **15**, 82-9.
2065. EPSTEIN, A. (1947), "Statistical analysis with hand-punched and sorted cards", *Amer. Statist.*, **1**, 6-7.
2066. FOSTER, G. A. R. (1946), "Some instruments for the analysis of time series and their application to textile research", *J. R. Statist. Soc. Suppl.*, **8**, 42-61.
2067. FREAR, D. E. H. (1945), "Punch cards in correlation studies", *Chem. Engng News*, **23**, 2077.
2068. FURRY, W. H. & HURWITZ, H. (1945), "Distribution of numbers and distribution of significant figures", *Nature, Lond.*, **155**, 52-3.
2069. GAGE, R. (1943), "Contents of Tippet's 'Random sampling numbers'", *J. Amer. Statist. Ass.*, **38**, 223-7.
2070. GARFATH, H. L. (1946), "A note on a formula of Newton and an extension thereto", *J. Inst. Actu. Stud. Soc.*, **6**, 63-6.
2071. GARFATH, H. L. (1947), "Tchebycheff's mean value theorem and some results derivable therefrom", *J. Inst. Actu. Stud. Soc.*, **7**, 70-80.
2072. GOMES, F. P. (1945), "Os gráficos—como se fazem e para que servem", *Rev. Agric., Piracicaba*, **20**, 261-8.
2073. GREVILLE, T. N. E. (1944), "The general theory of osculatory interpolation", *Trans. Actuar. Soc. Amer.*, **140**, 202-65.
2074. GROSCH, H. R. J. (1946), "Harmonic analysis by the use of progressive digitizing", *Proc. Res. Forum*, **81**, 4.
2075. GUMBEL, E. J. (1945), "Simplified plotting of statistical observations", *Trans. Amer. Geophys. Un.*, **26**, 69-82.
2076. GUTTMAN, L. (1946), "Enlargement methods for computing the inverse matrix", *Ann. Math. Statist.*, **17**, 336-43.
2077. HARTLEY, H. O. (1946), "The application of some commercial calculating machines to certain statistical calculations", *J. R. Statist. Soc. Suppl.*, **8**, 154-83.
2078. HOLLANDER, W. F. (1946), "Notes on graphic biometric comparisons of samples", *Amer. Nat.*, **80**, 494-6.
2079. HOTELLING, H. (1943), "Some new methods in matrix calculation", *Ann. Math. Statist.*, **14**, 1-34.
2080. HOTELLING, H. (1943), "Further points on matrix calculation and simultaneous equations", *Ann. Math. Statist.*, **14**, 440-1.
2081. JARCHO, S. (1945), "Equal-area projections and the azimuthal equidistant projection in maps of disease", *Amer. J. Publ. Hlth.*, **35**, 1005-13.
2082. JARRETT, F. F. (1946), "Normal approximations to the chi-square distribution", *Amer. Psychologist*, **1**, 454, Abstract.
2083. JONES, H. L. (1946), "Note on square-root charts", *Econometrica*, **14**, 312-5.
2084. KARSTEN, K. & BROOKS, E. (1943), "'Retro' charts", *J. Amer. Statist. Ass.*, **38**, 302-10.
2085. KEMPTHORNE, O. (1946), "The use of a punched-card system for the analysis of survey data, with special reference to the analysis of the National Farm Survey", *J. R. Statist. Soc.*, **109**, 284-95.
2086. KEMPTHORNE, O. (1946), "The analysis of a series of experiments by the use of punched cards", *J. R. Statist. Soc. Suppl.*, **8**, 118-27.
2087. KERN, E. M. (1945), "Multi-dimensional graphical representation for analyzing variation in quantitative characters", *Ann. Mo. Bot. Gdn.*, **32**, 279-81.
2088. KURTZ, A. K. (1946), "Scoring rating scales after the responses are punched on I.B.M. cards", *Proc. Res. Forum, Endicott (N.Y.)*, **28**-34.
2089. LADERMAN, J. & ABRAMOWITZ, M. (1946), "Application of machines to differencing of tables", *J. Amer. Statist. Ass.*, **41**, 233-7.
2090. LARSEN, H. D. (1947), "On graphical approximations to the mode", *Math. Mag.*, **21**, 35-9.
2091. LEVI, F. (1946), "Graphical solutions of statistical problems", *Engineer*, **182**, 338-40, 362-4.
2092. LONSETH, A. T. (1944), "On relative errors in systems of linear equations", *Ann. Math. Statist.*, **15**, 323-5.
2093. MCQUITTY, J. V. (1946), "Maximum use of mechanical aid in handling test results", *Proc. Res. Forum, Endicott (N.Y.)*, **52**-5.
2094. MICHALUP, E. (1946), "Beitrag zur Amortisationsrechnung", *Skand. Aktuar. Tidskr.*, **29**, 80-4.
2095. MICHEL, J. G. L. (1946), "Central difference formulae obtained by means of operator expansions", *J. Inst. Actu.*, **72**, 470-80.
2096. MOSIER, C. I. (1946), "Machine methods in scaling by reciprocal averages", *Proc. Res. Forum, Endicott (N.Y.)*, **35**-9.
2097. MYERS, R. J. (1947), "Laymen don't have logarithmic eyes: The case against the casual use of semi-log charts", *Amer. Statist.*, **1**, 17.
2098. NAYLOR, G. F. K. (1945), "Estimation of multiple correlation by means of stereographic projection", *Nature, Lond.*, **156**, 58-9.
2099. NEWTON, R. G. (1945), "A simplified method of calculating standard errors", *Chem. Ind. Rev.*, **64**, 322-3.

2100. NIELSEN, K. L. & GOLDSTEIN, L. (1947), "An algorithm for least squares", *J. Math. Phys.*, **26**, 120-32.
2101. PANSE, V. G. & AYACHIT, G. R. (1944), "Ten per cent probability of Z and the variance ratio", *Indian J. Agric. Sci.*, **14**, 244-7.
2102. PLATT, J. R. (1943), "A mechanical determination of correlation coefficients and standard deviations", *J. Amer. Statist. Ass.*, **38**, 311-8.
2103. RICHARDSON, J. T. (1946), "A table of Lagrangian coefficients for logarithmic interpolation of standard statistical tables to obtain other probability levels", *J. R. Statist. Soc. Suppl.*, **8**, 212-5.
2104. SATTERTHWAIT, F. E. (1944), "Error control in matrix calculation", *Ann. Math. Statist.*, **15**, 373-87.
2105. SIEGEL, I. H. (1943), "Note on a common statistical inequality", *J. Amer. Statist. Ass.*, **38**, 217-22.
2106. SIMONSEN, W. (1945), "On the numerical solution of systems of equations by means of iteration", *Skand. Aktuar. Tidskr.*, **28**, 154-70.
2107. SPOERL, C. A. (1944), "On solving simultaneous linear equations", *Trans. Actuar. Soc. Amer.*, **140**, 18-32.
2108. STEFFENSEN, J. F. (1945), "On certain formulas of mechanical quadrature", *Skand. Aktuar. Tidskr.*, **28**, 1-19.
2109. STEFFENSEN, J. F. (1945), "Further remarks on iteration", *Skand. Aktuar. Tidskr.*, **28**, 44-55.
2110. SWINEFORD, F. (1946), "Graphical and tabular aids for determining sample size when planning experiments which involve comparisons of percentages", *Psychometrika*, **11**, 43-9.
2111. SZATTOWSKI, Z. (1946), "Calculating the geometric mean from a large amount of data", *J. Amer. Statist. Ass.*, **41**, 218-20.
2112. TAYLOR, E. (1946), "The use of a single card column for recording variables with a range of 30 or fewer units", *Proc. Res. Forum, Endicott (N.Y.)*, 63-8.
2113. TUCKER, L. R. (1946), "Simplified punched-card methods in factor analysis", *Proc. Res. Forum, Endicott (N.Y.)*, 9-19.
2114. ULLMAN, J. (1944), "The probability of convergence of an iterative process of inverting a matrix", *Ann. Math. Statist.*, **15**, 205-13.
2115. VAUGHAN, H. (1946), "Some notes on interpolation", *J. Inst. Actu.*, **72**, 482-97.
2116. VINCENT, P. (1947), "Nomogrammes pour la détermination des différences significatives entre deux taux", *Population*, **2**, 313-22.
2117. WAUGH, F. V. (1945), "A note concerning Hotelling's method of inverting a partitioned matrix", *Ann. Math. Statist.*, **16**, 216-7.
2118. WAUGH, F. V. & DWYER, P. S. (1945) "Compact computation of the inverse of a matrix" *Ann. Math. Statist.*, **16**, 259-71.
2119. WREN, F. L. (1943) "The calculation of statistical moments" *J. Tenn. Acad. Sci.*, **18**, 204-10...

8. MISCELLANEOUS APPLICATIONS. P. ARMITAGE.

2120. ALLEN, P. (1945) "Lognormal distributions" *Nature, Lond.*, **156**, 746-7.
2121. ALLEN, P. & WALDER, P. S. (1945), "Accuracy of numerical frequency analysis of sediments", *Nature, Lond.*, **155**, 173-4.
2122. ALTMAN, O. L. & GOOR, C. G. (1946), "Actuarial analysis of the operating life of B-29 aircraft engines", *J. Amer. Statist. Ass.*, **41**, 190-203.
2123. BARRICELLI, N. A. (1943), "Les plus grands et les plus petits maxima ou minima annuels d'une variable climatique", *Arch. Math. Naturv.*, **46**, 155-94.
2124. BARTELS, J. (1943), "Statistik in der Geophysik", *Ann. Hydrogr., Berl.*, **71**, 107-14.
2125. BAUR, F. (1944), "Über die grundsätzliche Möglichkeit langfristiger Witternungs vorhersagen", *Ann. Hydrogr., Berl.*, **72**, 15-25.
2126. BEALL, G. (1947), "Quantitative treatment of density distribution pattern on photographic paper as produced by the disturbance of a spotlight galvanometer", *Paper Tr. J.*, **124**, 35-7; and *Paper Ind.*, **28**, 1801-2.
2127. BEARD, R. E. (1947), "Statistical problems of naval aircraft provisioning", *J. Inst. Actu. Stud. Soc.*, **6**, 144-8.
2128. BEER, A., DRUMMOND, A. J. & FÜRTH, R. (1946), "Sequences of wet and dry months and the theory of probability", *Quart. J. R. Met. Soc.*, **72**, 74-86.
2129. BERG, W. F. (1945), "Aggregates in one- and two-dimensional random distributions (Development of silver specks of known dimensions and the size of photographic sensitivity specks)", *Phil. Mag.*, **36**, 337-46.
2130. BERGEIRO, J. M. (1942), "Contribución al mayor conocimiento del clima. Concepto de especulaciones estadigráficas en Climatología Agrícola", *Inst. Est. Sup. Mont., Secc. Inv. Meteorolog.*, **3**, Montevideo.
2131. BLANCHE, E. E. (1946), "The mathematics of gambling", *Sch. Sci. Math.*, **46**, 217-27.
2132. BRODMAN, E., PHEULPIN, F. J. & DEUTSCHBERGER, J. (1947), "Some statistical methods useful to medical librarian", *Bull. M. Library, A*, **35**, 7-57.
2133. CHURCHILL, H. V. (1946), "A system of laboratory evaluation", *Industr. Engng Chem.*, **18**, 66.
2134. CHURCHILL, H. V. & CHURCHILL, J. R. (1945), "Evaluation of spectrographic analytical data", *Industr. Engng Chem.*, **17**, 751-4.
2135. CLARKE, R. D. (1946), "An application of the Poisson distribution", *J. Inst. Actu.*, **72**, 481.

1951]

2136. CUNNINGHAM, L. B. C. & HYND, W. R. B. (1946), "Random processes in problems of air warfare", *J. R. Statist. Soc. Suppl.*, **8**, 62-85.
2137. DAGOBERT, E. B. (1946), "Mathematical probabilities in games of chance: The game of sevens", *Math. Teach.*, **39**, 155-8.
2138. DANIELS, I. H. E. (1945), "The statistical theory of the strength of bundles of threads", *Proc. Roy. Soc., Ser. A*, **183**, 405-35.
2139. DEUTSCH, A. J. (1945), "The probability distribution around a fix in celestial navigation", *Amer. J. Phys.*, **13**, 379-83.
2140. ELDERTON, W. P. (1945), "Cricket scores and some skew correlation distributions (An arithmetical study)", *J. R. Statist. Soc.*, **108**, 1-11.
2141. EPSTEIN, B. (1947), "The mathematical description of certain breakage mechanisms leading to the logarithmiconormal distribution", *J. Franklin Inst.*, **244**, 471-7.
2142. FISHER, J. C. & HOLLOMAN, J. H. (1947), "A statistical theory of fracture", *Metals Technology*, **14**, 1-16.
2143. GARWOOD, F. (1947), "The variance of the overlap of geometrical figures with reference to a bombing problem", *Biometrika*, **34**, 1-17.
2144. GRENET, G. & BAYARD-DUCLAUX, F. (1945), "Application des méthodes statistiques à la climatologie", *C. R. Acad. Sci., Paris*, **221**, 632-4.
2145. GUMBEL, E. J. (1942), "Statistical control-curves for flood-discharges", *Trans. Amer. Geophys. Un.*, **23**, 489-509.
2146. GUMBEL, E. J. (1943), "On the plotting of flood-discharges", *Trans. Amer. Geophys. Un.*, **24**, 699-719.
2147. GUMBEL, E. J. (1945), "Floods estimated by probability method", *Engng News Rec.*, **134**, 833-7.
2148. HERDAN, G. (1943), "The logical and analytical relationship between the theory of accidents and factor analysis", *J. R. Statist. Soc.*, **106**, 125-42.
2149. HERSH, A. H. (1942), "Drosophila and the course of research", *Ohio J. Sci.*, **42**, 198-200.
2150. KOLMOGOROV, A. N. (Editor) (1945), "Collections of papers on the theory of artillery fire, I", *Trav. Inst. Math. Stekloff*, **12**, 106 pp.
2151. MASSÉ, P. (1944), "Application des probabilités en chaîne à l'hydrologie statistique et au jeu des réservoirs", *J. Soc. Statist. Paris*, **85**, 204-19.
2152. MAYHEW, W. L. & VAJDA, S. (1946), "An application of the theory of probability to the examinations of the Institute of Actuaries", *J. Inst. Actu. Stud. Soc.*, **6**, 67-75.
2153. MYERS, R. J. (1947), "Shuffle along to better hands", *Bridge-World*, **18**, 22-4.
2154. NEUBERGER, H. (1945), "A simple mechanical aid in the statistical analysis of climatic data", *Trans. Amer. Geophys. Un., Sect. Meteorol.*, **3**, 443-5.
2155. PENROSE, L. S. (1946), "The elementary statistics of majority voting", *J. R. Statist. Soc.*, **109**, 53-7.
2156. QUENOUILLE, M. H. (1947), "On the problem of random flights", *Proc. Camb. Phil. Soc.*, **43**, 581-2.
2157. RICHARDSON, L. F. (1944), "The distribution of wars in time", *J. R. Statist. Soc.*, **107**, 242-50.
2158. RICHARDSON, L. F. (1946), "The number of nations on each side of a war", *J. R. Statist. Soc.*, **109**, 130-56.
2159. RIDDELL, W. J. B. (1945), "The relation between the number of speakers and the number of contributions to the Transactions of the Ophthalmological Society of the United Kingdom between 1881 and 1890", *Ann. Eugen. Lond.*, **12**, 274-9.
2160. DE SAMPAIO FERRAZ, J. (1947), "Notas sobre a conveniência da expansao da climatologia fundamental; (estatística climatológica)", *Rev. brasil. Estat.*, **8**, 285-302.
2161. SCHUMANN, T. (1946), "Statistical weather forecasting", *Nature, Lond.*, **158**, 551-2.
2162. SILBERSTEIN, L. (1945), "The probable number of aggregates in random distributions of points", *Phil. Mag.*, **36**, 319-36.
2163. SILBERSTEIN, L. (1946), "On two accessories of three-dimensional colorimetry. I. The probable error of colorimetric tensor components as derived from a number of color matchings. II. The determination of the principal colorimetric axes at any point of the color threefold", *J. Opt. Soc. Amer.*, **36**, 464-8.
2164. SMITH, H. G. (1943), "Utility of statistical method in aerodynamics", *J. Amer. Statist. Ass.*, **38**, 341-5.
2165. SMITH, J. L. S. (1944), "The specification of disturbed periodic time series of the type of Wolfer's annual sunspot numbers", *J. R. Statist. Soc.*, **107**, 231-41.
2166. VAJDA, S. (1947), "Statistical investigation of casualties suffered by certain types of vessels", *J. R. Statist. Soc.*, **9**, 141-63.
2167. WAUGH, F. V. (1943), "Choice of the dependent variable in regression analysis", *J. Amer. Statist. Ass.*, **38**, 210-4.
2168. WEBB, J. N., NORTHROP, M. S. & PAYNE, S. L. (1943), "Practical applications of theoretical sampling methods", *J. Amer. Statist. Ass.*, **38**, 69-77.
2169. WENTWORTH, C. K. (1947), "Cycles in rainfall and validity in prediction of rainfall in Hawaii", *Pacif. Sci.*, **1**, 215-20.
2170. WILLIAMS, C. B. (1944), "The numbers of publications written by biologists", *Ann. Eugen., Lond.*, **12**, 143-6.
2171. WILM, H. G. (1943), "Efficient sampling of climatic and related environmental factors", *Trans. Amer. Geophys. Un.*, **24**, 208-12.

2172. WILM, H. G. (1946), "The design and analysis of methods for sampling microclimatic factors", *J. Amer. Statist. Ass.*, **41**, 221-32.
2173. WISHART, J. (1947), "Note on the probability distribution arising in the study of the Institute's examinations", *J. Inst. Actu. Stud. Soc.*, **6**, 140-3.
2174. WOOD, G. H. (1946), "Cricket scores and geometrical progression", *J. R. Statist. Soc.*, **108**, 12-22.
2175. WURTELE, M. (1944), "On the application of the theory of probability to meteorological statistics", *Bull. Amer. Met. Soc.*, **25**, 338-40.
2176. YARDI, M. R. (1946), "A statistical approach to the problem of chronology of Shakespeare's plays", *Sankhyā*, **7**, 263-8.
2177. YULE, G. U. (1946), "Cumulative sampling: a speculation as to what happens in copying manuscripts", *J. R. Statist. Soc.*, **109**, 44-52.
2178. YULE, G. U. (1944), *The Statistical Study of Literary Vocabulary*. Cambridge, Eng. Camb. Univ. Press, pp. x + 306.

1951]

REPORT OF THE COUNCIL

For the FINANCIAL YEAR ended December 31st, 1950, and for the SESSIONAL YEAR ended June 27th, 1951, presented at the ONE HUNDRED AND SEVENTEENTH ANNUAL GENERAL MEETING of the ROYAL STATISTICAL SOCIETY, held at the London School of Hygiene and Tropical Medicine, W.C.1, on June 27th, 1951.

Grants in Aid

DURING the past year the Society has been fortunate in receiving two exceptional and generous grants. In August, 1950, there was received the sum of £400 from the Scientific Publications Grant-in-Aid, a fund which is administered by the Royal Society. This grant was made, in answer to an appeal from the Council, to assist towards the cost of the *Journal Series B*, 1950. The relatively large amount of mathematical and statistical formulae in this issue, and customarily in *Series B*, adds very considerably to its cost of production. This factor, together with the continually increasing cost of paper and printing, has resulted in making the *Series* particularly expensive. The Council must inevitably accept its responsibilities in this field but yet cannot help being concerned from time to time at this item of the Society's costs. The realization of its position by the Royal Society and the resulting grant of £400 was accordingly received with much satisfaction.

In January, 1951, the Royal Society made a further grant for the same purpose of £350, bringing the total aid from this source to £750. This was the full amount for which the Council's application had originally been made. The deep appreciation of the Council, acting on behalf of all Fellows of the Society, was conveyed to the Royal Society.

It was also in August, 1950, that the Council learnt with great pleasure that the Trustees of the Rockefeller Foundation had approved a grant of \$20,000 for the improvement of the Society's Library and for the provision of additional secretarial and editorial assistance (the sum to be spent within the period of three-and-a-half years ending June 30th, 1954). This international recognition of the Society's position in the world of statistics was particularly gratifying to the Council for its policy has always been to enlist within the Fellowship of the Society all branches of statistical thought and work. In expressing its sincere thanks for this generous and very welcome assistance, the Council realizes that it is unnecessary to emphasize the very real claims of the purposes for which the grant was made. Those Fellows who have occasion to consult the Library will be well aware of the need to improve its facilities while those in touch with the work of the Society's staff realize the need of additional assistance.

The responsibility for advising the Council on the most effective way in which this grant shall be used has been remitted to its Benefaction Committee.

Number of Fellows

During the calendar year 1950 the number of Fellows increased by 129, bringing the total at December 31st to 2,193. Losses by death or withdrawal at 93 were rather less than in 1949 and thus reversed the rising figure of recent years. These losses too, were much more than offset by elections and restorations to the roll, which numbered 222. It will be seen, therefore, from the table (p. 2), that the decline since 1946 in the number of new Fellows elected was sharply arrested. There was, indeed, an increased entry compared with the previous year of no less than 33. The Council regards this with satisfaction and would particularly draw attention to the wide range of statistical interests represented by those securing election to Fellowship.

The 222 Fellows elected in this year are representative of the academic, scientific, commercial and industrial spheres, in each of which there has been increased understanding and use of statistical methods in recent years. There is no reason to believe that the important part which statistics has come to play in modern life is any transient phenomenon. This increased appreciation of the subject must be regarded as a permanent feature of the present world which depends so much on the basic conception of measurement. The Council fully realizes this situation and is accordingly anxious that the facilities provided by the Society will satisfy not only the increasing demands of existing Fellows but continue to prove attractive to those intending to embark on a

statistical career. It has, however, never been the policy of the Society to cater exclusively for the professional statistician and the Council hopes that it will, as a learned body, continue to attract those with a genuine interest in statistics though not professionally engaged in the subject.

Calendar Year	Number of Fellows (excluding Honorary Fellows)		
	Lost by Death, Withdrawal or Default	Elected, or Restored to the Roll	On the Roll at December 31st
1939	39	64	1,108
1940	76	47	1,079
1941	65	60	1,074
1942	69	74	1,079
1943	61	121	1,139
1944	29	159	1,269
1945	29	177	1,417
1946	56	287	1,648
1947	75	263	1,836
1948	96	238	1,978
1949	103	189	2,064
1950	93	222	2,193

The excess of elections over losses resulted in a record number of 2,193 Fellows on the roll at the end of 1950. This figure has further increased during the early months of the current year and at April 30th, 1951, the total amounted to 2,212. Thus the number of Fellows at the present time is double the number at the end of 1939.

Sixteen names were removed from the roll in March, 1951, as a result of a decision of the Council that Fellows who have paid a life subscription but whose addresses have been unknown for at least five years shall cease to be included in the current Fellows' List. The names of such Fellows will automatically be restored to the roll should the Society become aware of their current addresses.

At December 31st, 1950, there were 14 Honorary Fellows, including 7 who were Presidents for the time being of other Societies concerned with the advancement of statistical knowledge. The number of ordinary Fellows representing corporate bodies or institutions was 104.

Losses by Death

During the year ended April 30th, 1951, the Council regrets the loss by death of the under-mentioned Fellows:

	Date of Election
Alexander, C. S.	1908
*Bardell, A. P., F.S.A.A., F.C.I.S.	1921
*Barnett, B.	1947
cBasham, W. A., O.B.E.	1912
*Dewsnup, Professor E. R., M.A., F.R.G.S.	1900
cEpps, Sir George, K.B.E., C.B., B.A., F.I.A.	1936
*Giblin, Professor, L. F., M.A.	1926
Hunt, A. L.	1903
*Hutchinson of Montrose, the Rt. Hon. Lord, P.C., K.C.M.G., C.B., D.S.O.	1920
*Johnson, A. H. L.	1940
Keeney, R. D., A.B., M.A.	1950
Levitt, A.	1935
Low, A. C.	1926
Parkinson, Hargreaves	1929
cp†Rowson, Simon, M.Sc.	1904
Spencer, R. G., B.Sc.(Econ.)	1948
Spink, J. F., Litt.D., Th.D., Ph.D., M.R.S.L.	1947
cp*Thompson, R. J., C.B.	1901
*Tyler, E. A., F.S.A.A., F.C.I.S.	1892

* Life Fellow.

† Has received a Guy Medal.

c Served on Council.

p Contributed to *Proceedings*.

Mr. W. A. Basham had been a Fellow for practically 40 years and was a valued member of the Council from 1931/32 to 1933/34 and from 1937/38 to 1941/42. The early part of his official life was spent in the old Labour Department of the Board of Trade, and in the early years of this century he was the editor of the *Labour Gazette*, as it was then called. On the creation of the Ministry of Labour he transferred to the new Department where he stayed until retirement.

Sir George Epps took a close interest in the Society during his fifteen years of Fellowship and, before his retirement from the public service through ill-health, played an active part in its work. Elected in 1936, he served on the Council for the three following sessions and again in 1943/44. He was a Vice-President in 1941/42 and 1942/43, and a member of several Committees set up by the Council. His working life was spent in the Government Actuary's Department where, in 1936, he succeeded Sir Alfred Watson as the Government Actuary.

Mr. Hargreaves Parkinson, who died at the early age of 53, was a distinguished economic journalist. A man of deep economic understanding he plied his craft with great integrity, graduating from the *Economist* to become the Editor of the *Financial Times*. In the early nineteen-thirties, when the Society's Study Group (as it then was) was beginning to feel its way, Mr. Parkinson was a strong supporter and read several papers.

With the death of Mr. Simon Rowson, who was elected in 1904, the Society has lost one of its senior Fellows. He was a member of the Council from 1910/11 to 1915/16, and of the Library Committee until 1919/20. His paper read to the Society in 1913 on the Trade of the United Kingdom gained the award of a Guy Medal in Silver. He was deeply interested in Jewish Communal affairs and later in the film industry, a statistical survey of which, in 1934, was the subject of his last paper to the Society.

Mr. R. J. Thompson, a Fellow since 1901, had identified himself with the Society in many ways. His first paper, presented in 1904, was on Local Expenditure and Local Indebtedness in England and Wales. Four subsequent papers, the last in 1926, were on agricultural subjects and reflected his official life, which was spent in the Ministry of Agriculture. For many years he contributed the agricultural notes to the *Journal* and indeed had written one on the day of his death. As a Civil Servant he brought a scholarly mind to the administration of daily affairs.

Vice-Presidents

The Vice-Presidents of the Society appointed by the President for the Session 1950/51 were Mr. H. Campion, Mr. R. F. George, Dr. J. O. Irwin and Dr. Percy Stocks.

Meetings of the Society

The Ordinary General Meetings of the Society have continued to be held at the London School of Hygiene and Tropical Medicine. The Council wishes to record its appreciation of the facilities thus made available to the Society by the Board of Management and the Dean of the School, the Lecture Theatre of which admirably serves the purposes of the Society's meetings, and whose dining room provides a meeting place at tea time where unofficial statistical conversation ranges over a wide field.

The papers read during the Session and the attendance at meetings have been as follows:

1950	
November 22nd	BRADFORD HILL, Professor A. Presidential Address; The Doctor's Day and Pay. (160.)
December 18th	CARR-SAUNDERS, Sir ALEXANDER: Discussion on the Reports of the Royal Commission on Population—continued by Sir HUBERT HENDERSON, Sir GEORGE MADDEX and Professor D. V. GLASS. (170.)
1951	
January 24th	GRÜNHUT, Dr. M. Statistics in Criminology. (120.)
February 28th	DURBIN, J., and STUART, A. Differences in Response Rates between Experienced and Inexperienced Interviewers. (170.)
March 28th	MARTIN, Dr. W. J. A Comparison of the Trends of Male and Female Mortality. (90.)
April 25th	MORGAN, D. J., and CORLETT, W. J. The Influence of Price in International Trade: A Study in Method. (90.)
May 23rd	STAFFORD, J. Wholesale Price Indices. (160.)

While attendances have varied between 90 and 170, the numbers of Fellows and guests continue to show that all the papers read have been of general as well as particular interest.

Fellows are again reminded that offers of papers would be cordially welcomed. Indeed, it is only if Fellows come forward spontaneously with offers that a succession of meetings reflecting general interest can be maintained. In spite of the doubled Fellowship previously referred to the number of papers submitted is often disappointingly small. The Council believes that many of the newer Fellows must have original statistical matter to offer and urges them to be less backward in bringing their problems and their data before the Society. The special articles published in Series A of the *Journal* during the last two years shows, indeed, how wide the field is.

The Research Section

Professor M. G. Kendall has served for a second year as Chairman of the Research Section, and Mr. F. J. Anscombe was elected Honorary Secretary; other members of the Section's Committee have been: Professor G. A. Barnard, Dr. F. N. David, Dr. O. L. Davies, Mr. D. G. Kendall, Dr. P. A. Moran, Mr. D. Newman, Mr. R. L. Plackett, Dr. C. A. B. Smith, with Professor M. S. Bartlett and Mr. J. R. N. Stone nominated by the Council, Mr. E. C. Fieller nominated by the Industrial Applications Section, and Dr. J. O. Irwin an *ex-officio* member as Chairman of the Editorial Panel for Series B of the *Journal*.

During the Session four meetings have been held, at which the following papers were read:

1950	
November 29th	BOX, G. E. P., and WILSON, K. B. On the Experimental Attainment of Optimum Conditions.
1951	
January 31st	BARNARD, Professor G. A. The Theory of Information.
March 21st	KENDALL, D. G. Some Problems in the Theory of Queues.
May 30th	DANIELS, H. E. The Theory of Position Finding.

The Industrial Applications Section

The Section Committee which co-ordinates the functions of the separately organized Local Groups and links them with the Society has consisted of three members appointed by the Council (Dr. B. P. Dudding, Mr. W. J. Jennett and Mr. P. Lyle), three members appointed by the 1949-50 Section Committee (Mr. D. J. Desmond, Mr. G. H. Jowett, Miss J. Keen), and two representatives of each Local Group. Mr. Jowett was elected Chairman and Miss Keen, Honorary Secretary.

The main activities of the Section have been the organizing of a Conference on Industrial Statistics at Sheffield in September, 1950, the discussion of a new *Journal* on Applied Statistics and the usual discussion meetings of the Local Groups, organized by the Group Committees. The Officers of these Committees were:—

<i>Group</i>	<i>Chairman</i>	<i>Honorary Secretary</i>
Birmingham and District	Mr. W. A. Bennett	Mr. B. J. A. Martin
London	Mr. E. C. Fieller	Mr. E. D. van Rest
North-Eastern	Mr. N. J. Squirrell	Mr. H. Arnell
Sheffield	Mr. A. H. A. Wynn	Mr. A. H. Dodd
South Wales	Dr. T. V. Starkey	Mr. E. Lloyd
Tees-side (Sub-Group)	Mr. H. Kenney	Mr. J. T. Richardson

Investigations have been made into the possibility of forming a Group in Glasgow and exploratory meetings have been held. At the end of 1950, the total membership was about 520, of whom 310 are Fellows. During the Session 39 meetings have been held: 7 each in Birmingham, London and Newcastle (North Eastern); 6 in Sheffield; 4 in Billingham (Tees-side); 3 in Norton (Tees-side) and in Crumlin (South Wales); 1 in Newport and in Cardiff (South Wales).

The subjects for discussion have been:—

Birmingham and District Group

1950	
September 27th	Statistical Indices—W. A. Bennett.
October 25th	Statistics and the Craftsman—Joan Keen.
November 22nd	Codification of Hospital Records—Professor L. Hogben.
December 13th	Statistics and Production Engineering—L. H. C. Tippett.

Report of the Council

563

1951]

- 1951
February 28th The Interpretation of Inter-process Variability for Basically Different Products—V. E. Gough.
March 21st The Use of Punched Card Equipment for Statistical Analysis—S. Brand.
April 10th The Value of Statistical Methods of Control—P. Lyle.

London Group

- 1950
October 6th Statistical Problems of Personnel Management—B. Ungerson.
November 3rd Statistical Methods in Paint Technology—J. E. Mantell.
December 1st Statistics of the Sieving Process—G. Herdan.
- 1951
February 8th Applications of Factorial Analysis (Symposium)—Joint Meeting with the Study Section.
March 2nd Some Production Problems and Planned Works Experiments—A. D. Grace.
April 6th Subjective Judgment in Experimentation—G. Sears.
May 4th Graphical Analysis of Variations as a Production Tool—E. A. G. Knowles and C. Roseman.

North-Eastern Group

- 1950
October 18th Measurement of Industrial Productivity—P. D. Vincent.
November 7th Market Research.
December 13th Mechanical Recording and Computing Equipment.
- 1951
January 17th Statistics and Industrial Health—H. Campbell.
February 21st Statistics and Agricultural Research and Commercial Applications of Sampling—F. Hunter.
March 21st A Comparison of Different Types of Inspection—B. H. P. Rivett.
April 18th Statistics in Coal Technology—J. M. Runcie.

Tees-side Sub-Group

- 1950
October 11th A Chemist's Views on Variability—K. H. V. French.
November 8th Analysis of Production Costs—P. Lyle.
December 13th The Number of Observations required in Experiments—G. P. Sillitto.
- 1951
January 10th Statistical Aids to Management—L. H. C. Tippett.
February 14th Statistical Problems in Personnel Management—B. Ungerson.
March 21st The Application of Probability and Statistical Method to Electricity Supply—R. B. Rowson.
April 11th Some Aspects of Sickness Absence at Billingham—W. Spendley.

Sheffield Group

- 1950
October 26th Operational Research on the Output of Open Hearth Furnaces.
November 30th Control of Foundry Sand.
Index of Operational Efficiency for Reheating Furnaces—W. N. Jessop.
The Application of Statistics to Dust Problems in Coal Mines—J. G. Dawes.
- 1951
January 25th Statistics and Time Study—D. J. Desmond.
February 22nd Statistics and Personnel Problems—G. H. Jowett.
March 29th The Use of Statistical Method in the Development of Safer Mining Explosives—J. W. Gibson.
April 26th Accident Statistics—A. H. A. Wynn.

South Wales Group

1950	
November 3rd	The Statistical Approach to Time Study—D. J. Desmond.
December 8th	Statistical Techniques in Personnel Selection—T. V. Starkey.
1951	
February 2nd	Incentives and the Young Worker—L. T. Wilkins.
March 2nd	Listener Research—R. Silvey.
April 6th	Statistical Methods in Machine Utilization Studies—E. A. G. Knowles.

The following papers have been filed in the Society's library and may be borrowed on application:—

- The Application of Quality Control Charts to the Analysis of Costs, Productivity, etc.—G. F. Todd.
- Incentives and the Young Worker—L. T. Wilkins.
- Statistics and the Mechanical Engineering Dept.—W. R. Buckland.
- The Organization of a Statistical Department—A. W. Swan.
- The Application of Statistical Methods in American Steel Plants—D. R. G. Davies.

The Section held its first residential Conference at Sheffield University in September, 1950. Accommodation had been reserved for 100 people in the University Hostel, and more than 200 attended the meetings.

The Conference was opened by Professor Bradford Hill at 2.30 p.m. on Friday, September 29th. The first day's papers were primarily non-technical but subsequent meetings discussed for the benefit of practising statisticians novel applications of existing techniques. The general discussions emphasized the great need for a Journal catering for the interests of the Section. The papers, which are listed below, will shortly be available in book form.

- Contributions of Statistics to Industrial Production and Scientific Management—L. H. C. Tippett
- T. W. G. Boxall, A. Ellis, B. Moorhouse.
- Costing of Continuous Processes—P. Lyle.
- Summing-up of the Day's Proceedings—B. P. Dudding.
- The Cost of Inspection—F. J. Anscombe.
- Statistics Applied to Assembly Processes—G. A. Barnard.
- Improving the Precision of Measurements—W. J. Youden.
- Sequential Analysis of Machine Performance—B. H. P. Rivett.
- A Note on Productivity Measurement in the U.S.A.—H. Ingham.
- The Statistical Approach to Time Study—D. J. Desmond.
- Multiple Sampling in Theory and Practice—H. C. Hamaker and J. H. Enters.
- Problems in Even Flow in Production—E. D. van Rest.
- Graphical Analysis of Variations as a Production Department Tool—E. A. G. Knowles and C. Roseman.
- Discussion of a Proposed Industrial Applications Section of the International Statistical Institute.

The Study Section

The Study Section Committee for the Session has been Mr. L. T. Wilkins (Chairman), Mr. E. Shankleman (Secretary); Miss J. I. Douglas and Mr. B. Benjamin (Council representatives); other members, Mr. C. A. Moser, Mr. G. F. Todd, Mr. G. P. Salter and Mr. J. I. Mason.

The following nine meetings have been held in London during the Session.

1950	
October 12th	Statistics in Criminology—Dr. M. Grünhut.
November 9th	Symposium on Problems of Business Forecasting—C. Nuttall, A. P. Zentler and J. Downie.
December 14th	Consumer Panels in Market Research—N. J. Squirrell and A. G. Cranch.
1951	
January 11th	Symposium on Statistical Problems in Distribution—A. W. McIntosh, B. T. Ramm and E. A. Lever.
February 8th	Applications of Factorial Analysis—H. Eysenck, G. W. Scott-Blair, Max Hamilton and Ardie Lubin.
	(Joint Meeting with the Industrial Applications Section.)

Report of the Council

565

1951]

March 9th

Studies in British Marriage and Fertility Data—P. R. Cox and E. Grebenik.
(Joint Meeting with the Institute of Actuaries Students' Society.)

April 12th

Some Field Problems in Family Budget Enquiries—Professor Ian Bowen.

May 10th

Annual General Meeting, and Review of Literature.

Attendances at most of these meetings were very good and the subjects evoked considerable discussion.

Once again the Study Section and the London Group of the Industrial Applications Section have been extremely fortunate in having for their meetings the lecture theatre of the E.L.M.A. Lighting Service Bureau. The Council expresses its gratitude to the E.L.M.A. for their kindness in making this admirable hall available.

As a result of an open meeting in January, 1950, a local group of the Study Section was formed in Bristol with an Organizing Committee consisting of Mr. G. F. Todd (Chairman), Mr. W. R. Foster, and Mr. H. C. Mackenzie (Hon. Secretary). During the 1950-51 Session, six meetings were held in the University of Bristol. The subjects and speakers were as follows:—

1950

October 12th

The Efficiency of Sampling Methods—Dr. G. Herdan.

November 9th

Some Developments in Market and Advertizing Research in the U.S.A.—W. R. Foster.

December 14th

Prediction by Survey Methods—L. T. Wilkins.

1951

January 18th

Some Aspects of Quality Control—E. W. Lott.

February 14th

Problems in the Evaluation of Quality—F. H. George.

March 15th

Problems in a Recent Sample Survey—B. D. Copland.

Attendances have ranged from 57 to 27.

The Council is indebted to the University of Bristol for making the Reception Room available to the Group Committee.

Guy Medal

Accepting unanimously the recommendation of its Executive Committee the Council has pleasure in awarding a Guy Medal in silver to Mr. F. A. A. Menzler, C.B.E., F.I.A., for his paper entitled "London and its Passenger Transport System". Mr. Menzler's interest in the development and use of statistics has been evident for a very long time—as a member of the Government Actuary's Department (during which time he served on the Medical Research Council's Statistical Committee, and as Secretary of the Permanent Consultative Committee on Official Statistics), from 1922 to 1928, under whose aegis was published the Guide to Current Official Statistics, and subsequently in his distinguished work with the London Transport Executive. He has revealed these interests too in his very active association with the Society, upon the Council of which he is serving, and in the prominent place he has long occupied in the Institute of Actuaries, of which he is now the President. The Council is glad to acknowledge in this way Mr. Menzler's contributions to the cause of statistics.

International Statistical Institute

The Council was particularly happy to convey to Professor R. A. Fisher its cordial congratulations on his receiving the high honour of honorary membership of the International Statistical Institute. Congratulations were also conveyed to Dr. J. O. Irwin and Dr. J. Wishart on their election to membership of the Institute.

American Statistical Association

The Council extends its congratulations to the following Fellows of the Society on the honour of their election to Fellowship of the American Statistical Association: Professor R. G. D. Allen, Professor M. G. Kendall, Dr. P. V. Sukhatme, Mr. L. H. C. Tippett, Dr. J. Wishart, and Dr. H. O. Wold.

The Society's Examinations

Thirty-two candidates for all or part of the Society's Certificate and three for its Diploma presented themselves for the examinations held on March 28th, 29th and 30th. Certificates were consequently awarded to the following Fellows:

Butler, John Douglas
Clapp, Margaret Anne
Clarke, George William
Fakley, Dennis Charles
Hood, William Francis

Lindsell, Donald Albert
Matthews, Leonard Patrick
Nash, Frank Joseph
Naylor, Philip Edward
Newsam, John Oswald

As in previous years, the Council has to record its indebtedness to the London School of Hygiene and Tropical Medicine for granting the necessary facilities for the examinations in its Department of Medical Statistics and Epidemiology. It is not fully realized, perhaps, that in addition to the accommodation required, the Department, and the associated Statistical-Research Unit of the Medical Research Council, provides, through their nine Fellows of the Society, invigilation services which it would otherwise be difficult to secure. The Council is grateful to these Fellows at the London School of Hygiene and Tropical Medicine who kindly served in this capacity. The Council's thanks are also extended to its Examinations Committee, the membership of which has been: Mr. E. C. Fieller (Chairman), Professor R. G. D. Allen, Mr. B. Benjamin, Dr. D. J. Finney, Dr. H. O. Hartley, Professor E. S. Pearson, Mr. R. Stone, and Mr. N. L. Johnson (Honorary Secretary).

The Journal

Further progress has been made in reducing the delay in the publication of the *Journal*. It was hoped that the four parts of Series A for 1950 would be published within the same calendar year and this would indeed have been achieved had the printers not encountered a temporary difficulty in the paper supply. In the event Part IV was issued in February, 1951. Part I of the present session (containing the accounts of the Society's meetings in November and December) is now in the press. During 1950 there were issued 5 parts of Series A and 2 of Series B.

At its meeting in July, 1950, the Council decided that beginning with the issue of the *Journal* for Part I, 1951, the names of reviewers of books should be given, instead of their initials.

The editorial panel during the past year responsible for editing Series B has consisted of: Dr. J. O. Irwin (Chairman and Chief Editor), Mr. F. J. Anscombe, Professor G. A. Barnard, Professor M. S. Bartlett, Dr. H. E. Daniels, Dr. O. L. Davies, Mr. E. C. Fieller, Dr. H. O. Hartley, Mr. D. G. Kendall, Professor M. G. Kendall, Dr. C. A. B. Smith, Mr. R. Stone and Dr. F. Yates.

The publication of the series of articles on the statistics of various industries, commerce and sociological subjects, has continued under the general guidance of Professor M. G. Kendall, whose persuasions have materially added to the number of articles already prepared and in preparation. Up to and including those published in Part IV, 1950, seventeen have already been issued; four more are in proof. These contributions are a valuable guide to the better understanding of statistics commonly encountered by statisticians and other readers but the limitations of which are by no means always apparent to the non-expert in a particular field. The authority of the authorship of each of the articles is especially gratifying and the Council is sincerely grateful to the many authors who have contributed to this important series.

A feature of the *Journal* of recent years is its increasing size. In spite of the fact that the page is now larger than before the war by half as much again, the number of pages has steadily been increasing since 1947. It was apparent early in the present session that material available for the *Journal* for 1951 was not likely to lead to any substantial reduction. The Editors have thus to solve the conflicting claims for increasing demands on the space of the *Journal*, both Series A and B, and those of holding down the cost to reasonable proportions. The grant from the fund administered by the Royal Society, mentioned above, has done much to solve the problem. for the present year so far as *Journal B* is concerned; but assistance of this sort clearly does not absolve the Editors from keeping a very careful watch on the situation—and, indeed, may be said to increase their responsibilities. There is the additional problem of ensuring the adequacy of paper supplies, the present position of which precludes any tendency towards extravagance

While, therefore, the Council is anxious that the Editors of the Society's *Journals* should be able to give publication to all contributions of merit, it is inevitable that those of lesser, though good, quality must sometimes be rejected. It would also appeal to all Fellows to "edit" their papers carefully, removing unnecessary loquacity as well as obscurities that lead to the expense of proof corrections.

During the year the Council has had under consideration the issue of a journal specially devoted to the application of statistics in different practical fields and particularly in industry. It believes that such a journal is to-day greatly needed and it is now taking steps to set one up. Its first Editor, the Council is happy to announce, will be Mr. L. H. C. Tippet and it will be entitled *Applied Statistics*. Full particulars will shortly be sent to all Fellows and others likely to be interested.

The Library

The services given to Fellows and others authorized to use the Library during 1950 are summarized as follows, the figures in brackets giving the corresponding numbers in 1949 and 1948 respectively. The number of Fellows who borrowed books was 370 (345, 366) and between them they made 1,371 (1,169, 1,229) effective applications, borrowing 2,580 (2,032, 2,314) volumes. The preceding figures relate to volumes taken from the Society's premises by Fellows. The number of Fellows and Visitors using the Reading Room and the number of volumes consulted by them cannot be measured accurately. The number of signatures of Fellows and Visitors using the Reading Room was 597 (586, 603).

Non-serial works added to the Library during the year numbered 492 (537, 429). Serial publications (statistical reports and scientific and technical journals) are the larger part of the Library's annual intake of books, and in the current year the Library Committee paid particular attention to the provision of statistical journals. The Library is now receiving many journals not hitherto provided and efforts are being made to improve still further this side of the Library service by duplicating copies, for the most recent years, of journals in great demand.

A special study of all requests made for books which could not be met from the Library's resources was begun as an experiment early in 1949 and has been continued. The record has been examined regularly by the Library Committee and its policy respecting the provision of books has been largely based upon it. The record reveals that the ability of the Library to meet requests by Fellows during the period under review is much better than was believed before the record was started. Moreover, the Committee's efforts to strengthen possible weaknesses revealed by requests made by Fellows have met with some success already, for since the record was begun the proportion of books requested which are not in the Library has decreased considerably.

The grant of \$20,000 from the Rockefeller Foundation makes possible the improvement in the Library facilities to which reference was made in last year's Report to the Council. A thorough review of the Library has been initiated and it is hoped that within the next few years developments can be carried out which will provide the Society with a fully efficient Library Service.

Housing

It will be recalled from the Council's last Annual Report that the Society has been given a place among those learned societies which are, in due course of time, to be accommodated upon a central science site under the scheme administered by the Royal Society. The full realization of this scheme is of necessity a long-term question and cannot be fulfilled for several years. Nevertheless planning action has been taking place and the Council has appointed the President as its representative on the Royal Society's Accommodation Committee. The Society's requirements have already been broadly indicated.

There is a further consideration of which the Council is only too well aware—the pressing need of the Society's landlords, the London School of Economics, to secure the occupation of the premises in Portugal Street. The Council is, of course, anxious to do all it can to assist the London School of Economics and since the Society's accommodation in Portugal Street is becoming increasingly cramped it must be seriously considered whether it would not be in the Society's

own interests to surrender the remaining six years of its lease and rent some other accommodation for a few years. It would then be able to await its permanent home within the scientific societies' central site or take its time in seeking another independently. Properties brought to the notice of the Council's Benefaction Committee, which, on paper, gave promise of meeting the Society's requirements, have been considered with care. So far none suitable has been found. A very relevant and, indeed, fundamental point, recently made known by the Benefactor, is that if the Society should decide to accept accommodation with the other learned Societies on the central site, its benefaction of £30,000 may be converted into a capital endowment fund for the general purposes of the Society. In short the Society would then be generously endowed as well as centrally and liberally housed.

Finance

Appendices B and C consist of the abstracts of the Honorary Treasurer's Accounts, viz., the Statement of Income and Expenditure for the year 1950 and the Balance Sheet as at December 31st, 1950, together with the Auditor's report thereon.

Income, excluding Life Composition Fees, increased from £9,238 in 1949 to £10,279 in 1950. Of the two main sources of income, Fellowship Subscriptions rose by £434—the result mainly of the increase in the number of Fellows—but sales of the *Journals* rose only by £179, of which £122 was due to increased sales of *Journal B*.

There was a steep rise in expenditure, from £8,585 to £10,786. There were increases of £139 in salaries and wages, £100 on the Library and £301 on Stationery and miscellaneous printing. The rise in this last item was due to the cost of printing the 1949/50 edition of the List of Fellows.

The main increase in expenditure was, however, in the Publication and Distribution Expenses of the *Journals*, which rose from £4,390 to £6,280. In both 1949 and 1950 five parts of *Journal A* and two parts of *Journal B* were published. This increase in expenditure was due partly to the increase in the size of the two *Journals* but mainly to the continuing rise in costs of printing and paper. It may be observed that expenditure on the publication and distribution of *Journal A* exceeded receipts from sales by £1,306 in 1950 compared with £211 in 1949. For *Journal B* the excess of expenditure over receipts from sales was £1,172 compared with £556 in 1949.

As a result of the year's operations the surplus of £653 realized in 1949 was replaced by a deficit of £507 in 1950.

Composition fees, which fell from £429 in 1948 to £236 in 1949 rose to £418 in 1950. The composition fees (£77) of compounders who died during the year were transferred to the Accumulated Fund. The Composition Fee Fund, maintained at the total of composition fees received from Fellows still living, therefore amounted to £7,223 at the end of the year.

In May the Benefaction of £30,000 was transferred from Deposit Account and invested in 2½ per cent. Exchequer Stock 1955. The interest earned during the year, amounting to £484, has not been included in income but added to the Benefaction, which now stands at £30,484 and is shown separately in the Balance Sheet.

The Council and Officers

The Council in December regretfully accepted the resignation of Dr. A. H. Marshall from its membership. Mr. D. G. Kendall was co-opted in his place.

In accordance with the Bye-laws Fellows were invited to make nominations for the composition of the Council for the forthcoming Session. In the event, all the suggestions made were adopted and incorporated in the Council's recommendations which were circulated to all Fellows. No alternative proposals were received and the Fellows named below will be announced at the Annual General Meeting on June 27th, 1951, as having been elected as President, other officers and other members of the Council for the Session 1951–52.

The Council was unanimous in requesting Professor Bradford Hill to serve as President for a second year and was glad to receive his consent. The retiring members from last Session's Council are Professor J. H. Jones, Mr. D. J. Desmond, Professor D. G. Champernowne, Sir Henry Clay, Mr. W. Manning Dacey and, by resignation (due to his leaving London), Dr. Percy Stocks. The Council extends its thanks to these past members for their services.

1951]

Report of the Council

569

President

A. Bradford Hill.

Council

*R. G. D. Allen.
 M. S. Bartlett.
 B. Benjamin.
 W. R. Buckland.
 H. Campion.
 †E. Devons.
 Iris Douglas.
 B. P. Dudding.
 E. C. Fieller.
 *D. J. Finney.
 R. A. Fisher.
 H. O. Hartley.
 J. O. Irwin.

D. G. Kendall.
 M. G. Kendall.
 †G. H. Jowett.
 *Sir George Maddex.
 F. A. A. Menzler.
 E. S. Pearson.
 J. H. Richardson.
 J. Ryan.
 L. G. K. Starke.
 A. W. Swan.
 L. H. C. Tippett.
 †L. T. Wilkins.
 J. Wishart.

Honorary Treasurer

R. F. Fowler.

Honorary Secretaries

R. F. George.

Richard Stone.

Philip Lyle.

Honorary Foreign Secretary

R. F. George.

On behalf of the Council,
 A. BRADFORD HILL,
President.

R. F. GEORGE } *Honorary*
 RICHARD STONE } *Secretaries.*
 PHILIP LYLE }
 June 1st, 1951.

Those marked * were not Members of Council during the preceding session; those marked † have never served on the Council.

APPENDIX A

From June, 1950 to May, 1951, inclusive, the candidates named below were elected Fellows of the Society:

Anderson, John Leslie.
 Antill, Albert George.
 Archer, John.

Brown, Marion Irvine.
 Burford, John Farrant.
 Burrowes, William Dennis.

Bainbridge, Joseph Ronald.
 Baines, Christopher Richard.
 Baker, Antony Gordon.
 Banerjee, Durga Prosad.
 Banks, Barbara Joan.
 Barnett, Henry Arthur Rodney.
 Barr, Alexander.
 Battersby, Albert.
 Beach, Sydney Alfred.
 Beale, Evelyn Martin Lansdowne.
 Benjamin, Walter.
 Bhatt, Narbheshanker.
 Billington, Gordon Clement.
 Blandon, Edwin Ernest.
 Blight, Philip Arthur.
 Block, Lucy.
 Blunden, Ronald Massey.
 Borman, Phillip Anthony.
 Boyd, John Truesdale.

Cadwell, James Henry.
 Calvin, Lyle David.
 Campbell, Norman James.
 Cassagnol, Colette.
 Chaturvedi, Jagdish Chandra.
 Cleaver, Edith Winifred Lyle.
 Cotterill, Jack George.
 Cottrell, Henry Claude.
 Creasy, Monica Anne.
 Crowley, Francis Keble.

D'Abbs, Norman Leslie.
 Dainton, Harold Percy.
 Datar, Ravibhushan Anant.
 Davey, Harold.
 Davies, Raymond Arthur.
 Dehn, Conrad Francis.
 Dennis, Frederick Hamlyn.
 Dingwall-Fordyce, Ianthe.

Douglas, James Alexander Thomas.
Downham, John Stanley.
Downton, Harry Frank.

Elliott, Andrew Hilary.
Elston, Roger David.
Emblem, Leslie Francis.
Evans, Dennis Albert.
Evely, Richard William.
Ewan, William David.

Fairclough, Freda.
Farmer, Reginald Wilfred.
Field, Ernest Arthur.
Finlayson, Ronald John.
Flemhood, Joseph.
Ford, John Hugo.
Foxall, Douglas Henry.
Fraser, James Campbell.
Furlong, Colin Russell.

Gil-Pelaez, José.
Girschig, Robert Félix Henri.
Glass, Frederick Philip.
Godfrey, Arthur Irving.
Green, Alan Hollidge.
Green, John Robert.
Grove, Alan Albert.
Guha, Satya Priha.
Gunaratna, Llewelyn Frederick.
Gunlake, John Henry.
Gwilt, Richard Lloyd.

Hailstone, James Eric.
Harris, Amelia Isabelle.
Harris, John Leslie.
Harris, Walter Frank.
Hartston, William.
Hayes, Norman Henry.
Haynes, Alfred Trevor.
Haynes, Frank Edwin.
Heasman, Michael Anthony.
Henshaw, William Charles.
Hill, John Michael.
Hood, William Francis.
Hosker, Margery E.
Hosking, Gordon Albert.
House, Jean Florence.
Houthakker, Hendrik Samuel.
Huggett, Leonard George.
Hutton, David Graham.

Ibrahim, Mahmoud.
Iles, Donald Morton.
Innes, Evan.
Innes, Robert Francis.

James, Philip Gaved.
Jessop, William Neil.
Johnson, Matthew Henry.
Johnson, Ronald Henry.
Johnson, Stanley Neville.
Johnston, Margaret.

Keddie, Alexander Eric.
Knapman, Geoffrey John.
Knight, Ena Agnes.
Knight, Michael Anthony Gordon.

Laing, John.
Landsman, Bernard.
Lauderdale, Leslie Cecil.
Lee, Alec Miller.
Lewis, John Parry.
Livesey, Harold.
Long, Frank Arthur.
Lord, Reginald Douglas.

Mabane, the Rt. Hon. William.
McClelland, William Douglas.
MacDougall, Alastair Gordon.
Maguire, Brian Arthur.
Mason, Jack.
Mathur, Gauri Dayal.
Matthews, Leonard Patrick.
Mercer, Florence Edith.
Milligan, William Andrew Brown.
Mills, Donald Owen.
Monfort, Franz.
Moore, Frederick.
Mothes, Jean-Pierre.
Mulligan, John Arthur.
Murch, William Joseph.
Murteira, Bento José Ferreira.

Nash, Frank Joseph.
Naylor, Charles Frederick.
Neame, Edward Bennet.
Niaz, Mohammad Shafi.
Nickols, Denis Gregory.
Nuttall, Colin.
Nutting, Reginald Henry.

Oakland, Gail Barker.

Parekh, Chandulal Vrijlal.
Parekh, Harshadkant Chandulal.
Parkinson, Peter Gath Lindsay.
Payne, Peter Maurice.
Peet, Ian Falconer.
Penn, Colin Strathern.
Perry, Sidney James.
Philip, Norman Littlejohn.
Polanski, Henryk Stefan.
Polyani, George Michael.
Porteous, James.
Puddicombe, Léon John.

Richards, Robert.
Robb, Arthur Charles.
Roberts, George Woodrow.
Robertson, Douglas Stuart.
Robertson, Stewart Edward.
Rogers, William Graham.
Ross, Claud Richard.
Ross, John Muirhead.
Roufael, Salib.
Rudd, Ernest.
Runcie, James McIntyre.
Russell, William St. Clair.

Sahni, Inder Mohan.
Salmon, Edward Arthur.
Scrimgeour, David Alison Brown.
Shenton, Leonard Roy.
Siddiqi, M. R.
Sinkinson, Gordon.
Skinner, Arthur Allman.
Slade, Edward Henry.

1951]

Sleigh, Paul Anthony Crofton.
 Smith, Andrew.
 Smith, Anthony Robert.
 Smith, Oliver Douglas.
 Solari, Mary Elizabeth.
 Spence, Ashley Bertrand.
 Stringer, John.
 Sutton, Thomas Francis.

Tan, Sim Hong.
 Taylor, Wallis.
 Tetley, Herbert.
 Timberlake, Rupert Sydney.
 Tomlinson, Rolfe Cartwright.
 Tropp, Asher.

Vaidyanathan, Lalgudy Swaminath.

Walker, James.
 Walker, John Edwin Thomas.
 Walker, Kenneth Edward.
 Whyte, Ian David.
 Wilcock, George David Norwood.
 Williams, Evan James.
 Wood, John Keith Rainbird.
 Woodward, Arthur Charles.
 Woodward, Robert Henry.
 Wormald, Harry.

Yashanoff, Boris Alexis.
 Youden, William John.

Zalewski, Jan Wacław.

Corporate Representatives

Ashworth, Wilfred,
 Blackaby, Peter Norman,
 Brown, Douglas Arthur,
 Burton, George Vernon Kennedy,
 Clarke, George William,
 Fidgeon, Peter Lawrence,

Gorick, Harold E.,
 Harrison, William Arthur,
 Holford, Barbara Adelene,
 Hopper, Graham
 Lappin, John,

Snelling, Ernest David,
 Strachan, Daniel,
 Swinscow, Thomas Douglas Victor,

representing The British Nylon Spinners, Ltd.
representing J. Lyons & Co., Ltd.
representing Attwood Statistics, Ltd.
representing Fisons, Ltd.
representing The Ministry of Supply.
representing The Society of Motor Manufacturers and Traders, Ltd.
representing The Chamber of Shipping of the U.K.
representing Humber, Ltd.
representing The Bowater Paper Corporation, Ltd.
representing The Mond Nickel Co., Ltd.
representing The British Electricity Authority (Southern Division).
representing Gillette Industries, Ltd.
representing Henry Simon (Holdings), Ltd.
representing The British Medical Journal.

APPEN

STATEMENT OF INCOME AND EXPENDITURE

EXPENDITURE										1950	
1949										£	£
£	£										
	380	Rent	...	...	...	...	...	...	...		380
	404	House expenses	...	...	...	...	...	...	...		332
		Salaries and wages (including contribution to staff superannuation scheme)	...	...	...	...	...	...	...		1,952
	1,813	Pension and allowance	...	...	...	...	...	...	...		222
	239	Insurance	...	...	...	...	...	...	...		21
	20	Office equipment	...	...	...	...	...	...	...		4
	45	Postage and telephone	...	...	...	...	...	...	...		103
	113	Stationery and miscellaneous printing	...	...	...	...	...	...	...		551
	253	Publication and distribution expenses:									
		Journal, Series A (General) and reprints	...	...	...	...	...	...	...	4,070	
	2,918	Journal, Series B (Methodological) and reprints	...	...	...	...	...	...	...	2,210	
	1,472										6,280
	—	4,390									
		Library:									
	127	Books	...	...	...	...	...	...	...	155	
	49	Binding	...	...	...	...	...	...	...	121	
	—	176									276
	145	General Meetings—ordinary and annual	...	...	...	...	...	...	...	161	
	39	Council and committee travelling expenses	...	...	...	...	...	...	...	22	
		Expenses of sections:									
	67	Research	...	...	...	...	...	...	...	62	
	244	Industrial applications	...	...	...	...	...	...	...	235	
	25	Study	...	...	...	...	...	...	...	29	
	—	336									326
		Guy Medal	...	...	...	...	...	...	...	7	
		Examination expenses:									
	66	Printing, stationery, postage etc.	...	...	...	...	...	...	...	36	
	77	Examiners' fees	...	...	...	...	...	...	...	31	
	—	143									67
	37	Auditor's fee (1949)	...	...	...	...	...	...	...	37	
	52	Miscellaneous expenses	...	...	...	...	...	...	...	45	
	—	8,585									10,786
		Balance carried to Accumulated Fund, being excess of income over expenditure for the year	...	...	...	...	...	...	...	—
	653										10,786
	—	9,238									418
	236	Amount carried to Life Composition Fee Fund	...	...	...	...	...	...	...	—
	—	£9,474									£11,204

DIX B

FOR THE YEAR ENDED 31st DECEMBER, 1950

0
£
380
332
1,952
222
21
4
103
551
6,280
276
161
22

$$\begin{array}{r} 326 \\ 7 \\ \hline 67 \\ 37 \\ 45 \\ \hline 10,786 \\ \cdot \\ \hline 10,786 \\ 418 \\ \hline 11,204 \end{array}$$

FUNDS AND LIABILITIES

1949			1950
£	£		£
		<i>Accumulated Fund:</i>	
6,863		Balance at 31st December, 1949	7,642
126		Add: Amount transferred from Life Composition Fee Fund ...	77
653		Excess of income over expenditure for the year 1949 ...	—
			7,719
7,642		Less: Excess of expenditure over income for the year 1950 per annexed account	507
	7,642		7,212
		<i>Life Composition Fee Fund:</i>	
6,772		Balance at 31st December, 1949	6,882
236		Add: Life Composition Fees received during year	418
			7,300
7,008		Less: Contributions of compounders who died during year transferred to Accumulated Fund	77
126	6,882		7,223
		<i>Building Fund (per contra):</i>	
1,237		Balance at 31st December, 1949	1,283
46		Add: Income for year	48
	1,283		1,331
		<i>1950 Benefaction Fund (per contra):</i>	
		Amount of Benefaction	30,000
		Add: Income to 31st December, 1950	484
			30,484
		<i>Liabilities and Income held in suspense:</i>	
2,204		Sundry Creditors	2,060
		Amounts received in advance:	
303		Annual subscriptions	290
1,058		Payments for Journals	923
28		Examination fees	46
	3,593		3,319
	19,400		49,569
		<i>Frances Wood Memorial Fund (per contra):</i>	
542		Balance at 31st December, 1949	503
21		Add: Income for year	20
			523
563		Less: Prizes awarded in 1949	—
60	503		523
	<u>£19,903</u>		<u>£50,092</u>

A. BRADFORD HILL, *President.*R. F. FOWLER, *Honorary Treasurer.*

Report of the Council

575

1951]

DIX C

31st DECEMBER, 1950

ASSETS

1949	1950
£	£
<i>Investments at cost or under:</i>	
5,580	£10,527 12s. 3d. 2½% Consols (Guy Bequest) ... 5,580
1,185	£2,236 11s. 3d. 2½% Consols ... 1,185
1,324	£1,864 14s. 1d. 3½% Conversion Loan ... 1,324
490	£500 3½% War Loan ... 490
1,486	£1,486 13s. 10d. 3% Savings Bonds 1955-65 ... 1,486
2,992	£2,970 1s. 10d. 3% Savings Bonds 1965-75 ... 2,992
2,000	£2,000 3% Defence Bonds ... 2,000
100	£194 16s. 1d. 3% British Transport Guaranteed Stock 1978-88 ... 100
15,157	15,157
(Market Value, less interest accrued, 31/12/49 £17,534, 31/12/50 £17,800.)	
<i>Building Fund:</i>	
1,283	£1,401 4s. 8d. 3½% Conversion Loan ... 1,331
(Market Value 31/12/49 £1,270, 31/12/50 £1,349.)	
<i>1950 Benefaction Fund:</i>	
	£30,000 2½% Exchequer Stock 1955 ... 30,157
(Market Value 31/12/50 £30,487.)	
	Interest accrued ... 253
	Cash at bank ... 74
	30,484
<i>Current Assets:</i>	
512	Debtors and amounts paid in advance ... 510
84	Arrears of subscriptions recoverable (estimated) ... 84
172	Interest accrued on investments (gross) ... 172
2,192	Cash at banks and in hand ... 1,831
2,960	2,597
19,400	49,569
<i>Frances Wood Memorial Fund:</i>	
300	£512 12s. 6d. 3% British Transport Guaranteed Stock 1978-88 ... 300
(Market Value, 31/12/49 £461, 31/12/50 £469.)	
199	Post Office Savings Bank Deposit ... 223
4	Income tax refund due ... 523
503	

NOTE.—No value is placed in the Accounts on—

- (1) Journals and other publications in stock.
- (2) Books in library.
- (3) Pictures, furniture and equipment.

£19,903

£50,092

REPORT OF THE AUDITOR

I have obtained all the information and explanations which to the best of my knowledge and belief were necessary for the purposes of my audit. In my opinion proper books of account have been kept by the Society so far as appears from my examination of those books.

I have examined the above balance sheet and annexed statement of income and expenditure which are in agreement with the books of account. In my opinion and to the best of my information and according to the explanations given me the Balance Sheet gives a true and fair view of the state of the Society's affairs as at 31st December, 1950, and the statement of income and expenditure gives a true and fair view of the income and expenditure for the year ended on that date.

5, London Wall Buildings, E.C.2,
16th Nov, 1951.
VOL. CXIV. PART IV.

RAE SMITH, Auditor.
Chartered Accountant.

PROCEEDINGS OF THE ONE HUNDRED AND SEVENTEENTH ANNUAL GENERAL MEETING OF THE ROYAL STATISTICAL SOCIETY, held at the London School of Hygiene and Tropical Medicine, on Wednesday, June 27th, 1951.

The Chair was taken by the President, Professor A. Bradford Hill, D.Sc., Ph.D.

The President presented the Report of the Council for the financial year 1950 and the session 1950-51, and moved that it be adopted.

During his submission of the Report he presented a Guy Medal in silver to Mr. F. A. A. Menzler, and Certificates to the successful candidates in the 1951 Certificate examination who were able to be present at the meeting.

The Honorary Treasurer, Mr. R. F. Fowler, presented the accounts and seconded the motion for the adoption of the Report.

On the proposal of Dr. David Heron, seconded by Dr. Irwin, Sir Alan Rae Smith was re-elected Auditor of the Society for the session 1951-52 at a fee of thirty-five guineas.

The President announced that as no alternative nominations had been received, the President, Council, and Officers for the session 1951-52, nominated as shown on the list already circulated, were duly elected.

The Report was unanimously adopted.

The meeting then terminated.

The Annual General Meeting was preceded by an Ordinary Meeting at which the candidates named below were elected Fellows of the Society:

Joséph Ball.
Colin Beal.
M. T. L. Bizley.
Cecil Douglas Blyth.
Mahmoud El-Adly.
Brian Patrick Emmett.
William Richardson Foster.
Bernard Henry Gales.
Reginald Harry Greenlands.
Harold Franklin Greenway.

John William Hopkins.
Robert Morley Jones.
Nathan Keyfitz.
André G. L. Laurent.
Harry Gordon Lee.
Angus McPhee.
John Thornton Marshall.
John Everett Robbins.
William Kenneth Sandham.

Corporate Representatives

V. W. J. Pendred, *representing* the Regent Street Polytechnic School of Commerce.
A. W. Tuke, *representing* Barclays Bank Ltd.

REVIEWS OF STATISTICAL AND ECONOMIC BOOKS

CONTENTS

	PAGE
1.—Kuhn (H. W.) and Tucker (A. W.). (Ed.) Contribution to the Theory of Games	577
2.—Munroe (M. E.) Theory of Probability	578
3.—Fortet (R.). Calcul des Probabilités	578
4.—Whittle (P.). Hypothesis Testing in Time Series Analysis	579
5.—Chambers (E. G.). Psychology and the Industrial Worker	579
6.—Chang (Tse Chun). Cyclical Movement in the Balance of Payments	580
7.—Jaffe (A. J.). Handbook of Statistical Methods for Demographers	581
8.—United Nations Dept. of Economic Affairs. Economic Survey of Europe in 1950	582
9.—National Bureau of Economic Research. Conference on Research in Income and Wealth	583
10.—Vance (L. L.). Scientific Method for Auditing	584
11.—Morey (L.) and Hackett (R. P.). Fundamentals of Government Accounting	586
12.—Wilkins (L. T.). Domestic Utilization of Heating Appliances and Expenditure on Fuels in 1948/1949	587

1.—*Contribution to the Theory of Games*. Edited by H. W. Kuhn and A. W. Tucker. (*Annals of Mathematics Studies*. No. 24.) Princeton University Press, 1950 (London: Oxford University Press). xxv + 201 pp. 10". 20s.

The theory of games was first introduced by John v. Neumann in a talk to the Goettingen Mathematical Society, which appeared subsequently in print in 1928 (*Mathematische Annalen*, vol. 100). It was then a purely mathematical structure without any claims to applications. It became more widely known in 1944 through the appearance of the book *Theory of Games and Economic Behavior* by J. v. Neumann and O. Morgenstern. The second author lent his authority as a professor of economics to the claim that the theory might throw some light on the problems referred to in the second part of the title. Little was added to the original mathematical theory; the main advance consisted in the proof that zero-sum two-person games with "complete information" (concerning all previous moves) are always specially strictly determined. It may be assumed that the interest of statisticians centred on the connection of the theory with economic matters. More interest was added from a completely different angle, though again through economics. It happens that mathematical problems arising in that design of planning called linear programming are similar to those in the theory of games. This is so because in both theories the mathematical model consists of sets of linear equations or inequalities, where the admissible solutions are restricted to a well-defined set of numbers: in the theory of games mixed strategies contain the pure strategies in non-negative proportions, whereas in programming every activity produces a non-negative yield. However, a much deeper reason for the concern of statisticians with the theory of games lies in the parallelism between the aims of a player with his strategies and those of a statistician with his decision functions, as conceived by A. Wald, whose book, *Statistical Decision Functions*, was recently reviewed in this Journal. Wald was, of course, compelled to extend the original theory very considerably. J. v. Neumann had only considered finite sets of strategies, but the analogy with statistical problems demanded infinite sets. Even J. Ville's earlier extension to continuous sets of strategies (in *Traité du Calcul des Probabilités et de ses Applications*, edited by E. Borel, vol. 2, no. 5) did not suffice for Wald's purpose.

The theory of games has also benefited from the obvious possibility of applying it to military matters, from which the term "strategy" has, after all, been derived. Operational Research has indeed made much use of the relevant concepts, particularly in the U.S.A. Problems of combat, of deployment of forces and similar questions fit easily into this context. The book under review is, however, strictly limited to purely mathematical aspects. From this point of view it deals with results belonging to the theory of convex sets. Thus Part I starts off with a translation of the fundamental paper, "The elementary theory of complex polyhedra" by H. Weyl (from *Comm. Math. Helv.*, 7, 1935). It then goes on to deal with the Main Theorem (due to J. v. Neumann), which asserts that always

$$\text{Max}_x \text{Min}_y \sum_i \sum_j a_{ij} x_i y_j = \text{Min}_y \text{Max}_x \sum_i \sum_j a_{ij} x_i y_j,$$

where a_{ij} is the amount which player I receives from player II if the former uses his i^{th} and the latter his j^{th} strategy, whereas x_1, \dots, x_m and y_1, \dots, y_n are respectively the proportions in which the two players mix their pure strategies in a series of plays. Investigations are included into procedures which lead to the solutions x_i and y_j producing the MaxMin and simultaneously the MinMax mentioned above. (These solutions need, of course, not be unique.) The last two of the eleven papers in Part I deal with n -person games. The four papers of Part II consider games with an infinity of strategies, in particular those where the pay-off resulting from any pair of strategies is expressed by a simple formula.

The two editors and twelve other authors have covered the most recent advances of the theory, and the Introduction gives a valuable outline of outstanding problems. The pages are mimeographed, and hence some formulae demand the concentrated attention of the reader.

S. VAJDA.

2.—*Theory of Probability*. By M. E. Munroe. New York and London: McGraw-Hill, 1951. v + 213 pp. 38s. 6d.

This book on the theory of probability has arisen from a course given by the author at the University of Illinois. It contains chapters on permutations and combinations, elementary probability theorems, joint probability laws, the binomial, random variables, moments, limit theorems and laws of large numbers. The treatment throughout is on an elementary level, and the book could be read by any first-year university student working on his own.

Uspensky's *Introduction to Mathematical Probability* and Feller's *Introduction to Mathematical Probability and its applications* are two books on probability which have been produced in America and which appear destined to become classics. It is difficult to see that there is any ground covered by this book which is not covered with greater clarity and width of exposition by Uspensky and Feller.

F. N. DAVID.

3.—*Calcul des Probabilités*. By R. Fortet. Paris: Centre National de la Recherche Scientifique, 1950 (London: H. K. Lewis). 330 pp. 9½". 27s.

To students of probability any book emanating from the French school is an event of importance. One has only to look back on the books edited by M. Borel, now classics, which have carried the ideas and development of a rigorous calculus of probability to the mathematical and statistical worlds, to realize how great has been the French contribution to the mathematics of probability. All these volumes, containing as they do the developments of probability theory necessitated by the application of this calculus in diverse fields, have at least one thing in common. Besides sharing mathematical rigour, they also share a seemingly deliberate avoidance of any practical ideas. It is almost as though, in the past, the French probabilists have considered it sufficient to produce the theory and leave the applications to others.

This last being the case it is a surprise and delight to find that under the guise of a book on the calculus of probability M. Fortet has not only written a text-book with modern statistical applications, but has written it very well. It is true that the weighting is still rather heavily on the side of probability calculus but there is a certain amount of discussion on testing hypotheses, and the last chapter on examples of various applications of the theory will be of interest to statisticians of diverse interests. M. Fortet might well have gone further and added a discussion of applications of his theoretical results to the researches of his distinguished fellow countryman, M. de Tessier, but possibly this is being a little ungenerous.

It having been said that this is a book of importance the reviewer may perhaps be permitted a few small grumbles. It will be universally admitted that the major contributions during the past three decades to the theory and practice of statistics have been made by English and American statisticians, following the work of R. A. Fisher. It is therefore at the same time both irritating and amusing to find a text-book with applications of the probability calculus to statistics, having a bibliography containing 109 entries with one reference to R. A. Fisher (name misspelt), one reference to M. G. Kendall (initials wrong), one reference to A. Wald, and no reference to either J. Neyman or E. S. Pearson. There are doubtless good reasons for this, just as there are probably good reasons why it is necessary to give well known statistical terms a different French name. The reviewer feels that statisticians could learn here from the biologists, who show a willingness to use a technical term in the language in which it originated.

It is fair to say that this book of M. Fortet will be read with interest by all statisticians interested principally in the calculus of probability and its applications. The book will be too theoretical for the applied statistician, while the would-be student of statistical methods will find his needs

very much better catered for in his own language. Nevertheless this book is of importance in that its outlook is much more practical than anything else the reviewer has seen entitled "Calcul des Probabilités", and M. Fortet is to be congratulated on his work.

F. N. DAVID.

4.—*Hypothesis testing in Time Series Analysis*. By Peter Whittle. Uppsala: Almqvist & Wiksell, 1951. 121 pp. 9½".

This pamphlet is a doctorate thesis presented to the University of Uppsala and written under the direction of Wold. It discusses the theory of various tests useful in the analysis of time series.

After two introductory chapters summarizing, in a pleasantly elegant way, the theory of testing statistical hypotheses and the spectral theory of stationary stochastic processes, there follow three chapters on tests of hypotheses which fully specify the process, i.e., those for which no fitting is necessary. The first of these shows how test criteria in such a situation can be based on likelihood ratios. Such test criteria usually turn out to be ratios of two quadratic forms, and the next chapter discusses how approximate distribution for such ratios can be found. Particularly elegant here is the author's use of matrix theory, and his close linking of the theory of the distribution of test criteria with the spectral generating function. In another chapter the author applies such a method to test for randomness a series of Wold's random normal deviates. The next group of three chapters discusses methods of discrimination between different models for an observed time series without specifying the actual values of the parameters involved. Once again an asymptotically most powerful test is set up, its asymptotic distribution found and an application given to a particular numerical case where it is desired to discriminate between an autoregressive scheme and a scheme of moving averages.

The thesis concludes with a chapter on testing periodograms and one on indeterminacies in model construction which are very similar to the problems of "identification" recently raised by the econometricians. This book is a powerful and original contribution to the theory of time series and should be read by all concerned with this subject.

P. A. MORAN.

5.—*Psychology and the Industrial Worker*. By E. G. Chambers. Cambridge University Press, 1951. 190 pp. 7¼". 10s. 6d.

This is an extremely useful little book. It gives a short account of the whole field of industrial psychology, covering both the purposes and achievements of that subject.

The author has been connected with the Industrial Health Research Board all his working life, and a perusal of the 119 references which he gives makes clear how great has been the contribution to the whole subject of the Board and its staff. Statistical method has permeated industrial psychology, for which it is an absolutely fundamental discipline; no apology is therefore necessary for reviewing here a book which is mainly devoted to results and, apart from the last two chapters and the appendix, not concerned with the technicalities of our subject.

The first seven chapters are concerned with vocational guidance and selection, training, the physical environment, the time factor and the psychological environment. There follow chapters on the health of the worker, on the worker as a member of society, on psychological tests, and on test scores and measurement scales.

The style is extremely lucid, and the first 150 pages could be read with appreciation by any intelligent layman; the last two chapters are somewhat more technical.

The chapters on vocational guidance and selection are particularly interesting. The author's conclusion is that in his view "the useful scope of vocational selection is considerably less than is generally claimed. The bulk of the working population is capable of tackling adequately most of the ordinary tasks of industry, and the better approach towards fitting the man to the job is, in the writer's opinion, by means of vocational guidance. Where selection is most necessary, there the devising of selective tests is the hardest and the validation of the procedure the most difficult. This is often due to the lack of an adequate criterion of industrial efficiency". It is inevitable in the present state of development of the subject that there will be much difference of opinion on this conclusion.

The chapter on training is concerned with time and motion study, teaching the trainer—learning and learning curves as well as with transfer of training, speed and accuracy and motivation in learning.

In the chapter on physical environment, the relation to the job and to the design of machinery of physique and physical fitness is shortly discussed. Temperature, ventilation and humidity, barometric pressure, illumination and noise are then considered. Next come other environmental factors such as canteens, lavatories, drying rooms and dust. "Even on the mere financial basis, improvement of physical conditions usually pays a dividend in the form of increased output and

a general rise in efficiency. More important from a social point of view is the effect on the satisfaction of the workers caused by a congenial and pleasant environment." "The Time Factor" deals with the relation to efficiency of hours of work, rest pauses, arrangement of shift work, rate of working and flow of work. The use of work curves is illustrated. "The Psychological Environment" considers incentives, boredom and monotony and relations with fellow workers and superiors.

In the chapter on the health of the worker, sickness records and statistical investigations based on them are first discussed. There is a short discussion of investigations into particular maladies such as miners' nystagmus and telegraphists' cramp. The evidence that these maladies may be psycho-neurotic in character leads on to a general discussion of mental health in industry. Then comes a section on fatigue and one on accidents and accident proneness that should be of particular interest to statisticians.

Chapter IX, on "The Worker as a Member of Society", puts forward the view of a psychologist on problems which are generally regarded as political. The author considers that one of the chief causes of industrial unrest is the breakdown of personal and social relationships brought about by centralization and remote control. This chapter is admirably written and presents a convincing case.

The last two chapters, on psychological testing, test scores and measurement scales, will be of particular interest to statisticians in their professional capacity. The author has some pertinent things to say on so-called tests of "reliability" which he rightly thinks should be called tests of consistency, and of the fallacy of applying them to a select group. He adopts Norman Campbell's classification of measurement scales into nominal, ordinal, interval and ratio scales, and indicates what statistical methods it is legitimate to apply to each.

Just because of the very large number of scientific techniques involved in the study of industrial psychology, it is a subject whose literature is very difficult to summarize. There are many unsolved problems. The author has succeeded admirably in his task of providing a short and easily readable account, in which his own views on matters which are still unsettled are always distinguishable from established facts.

J. O. IRWIN.

6.—*Cyclical Movement in the Balance of Payments*. By Tse Chun Chang. Cambridge University Press, 1951. x + 224 pp. 8½". 18s.

The study of the behaviour of the different items in the balance of payments is of great practical importance. It may be remembered that, shortly before the devaluation of the pound in 1949, voices were heard from the ranks of professional economists saying that devaluation would do no good; that it might even be better to change the exchange rate in the opposite direction. There was at the time no firm basis of fact on which a decision could have been made either way; it was necessary for the Government's advisers to work on intuition and guesswork, and they might still have been trying to make up their minds if the issue had not been part-decided by the growth of a belief that devaluation was coming.

The purpose of Dr. Chang's study, a Cambridge Ph.D. thesis, is to assemble basic statistical data about the behaviour of the items in the balances of payments of different types of country, over the inter-war period 1924–38. After a short theoretical introduction he discusses general factors affecting the demand for imports and exports; and he then considers in turn the balances of payments of Britain, America, Sweden, Australia, Chile and Canada, showing how their constituent items varied with the phases of the inter-war trade cycle. I propose to select from this rich feast of statistics, presented on the whole with an attractive clarity, a few of Dr. Chang's conclusions; and then to ask whether these conclusions are justified by the evidence.

1. The propensity to import of a country is the greater the higher its real income per head, and the greater the degree of specialization of its production. This is a common-sense conclusion, and we need not perhaps be unduly perturbed because the measures of degree of specialization used will alter considerably with the product classification adopted.

2. The income elasticity of demand for imports is about 1½ for the world as a whole, but is higher for agricultural and mining countries and lower for the U.S. (1·27) and the U.K. (1·10). The price elasticity for a change in *relative* prices, varies widely between ¼ and over 1, being about 1 for the U.S.A. and ¼ for the U.K.

3. The income elasticity of the world demand for exports ranges from 1 to 3 for the exports of the industrial countries and of the producers of industrial materials, but from 0·2 to 0·9 for the agricultural countries. The relative-price elasticities are around ½ for the industrial countries, and are scattered around 1 for the agricultural countries.

4. On p. 77 is found a table of that important quantity, the sum of the import and export price elasticities. If this exceeds a certain critical value, which in a simple case is unity (but is probably higher for the U.K.), it is to be expected that exchange depreciation would produce a

favourable change in the balance of trade. The figure for the U.K. is well below unity, so that the expected change would be unfavourable, except (see p. 78) for a very sharp devaluation—in the limit, one which reduces imports to zero while exports must still have a positive value. It is perhaps as well that Dr. Chang's book was not before us in 1949! But on p. 77 Dr. Chang makes the very important remark that in some cases the balance of the invisible items will move in the opposite direction to that of the visibles.

5. The later chapters show a general tendency for the cyclical movements of the balance on income account to be offset by similar changes in long-term capital movements, so that the gap to be filled by movements of short-term capital or of gold remains within narrower bounds than the changes on income account would suggest.

6. Industrial countries (U.K., U.S.) tend to show a surplus on income account with world prosperity and a deficit with world depression. The British cycle being (in the period discussed) less violent than the world cycle, this tendency is enhanced; while the U.S. cycle is (or was) more violent than the world cycle, and the tendency is thus damped. This effect of differences in amplitude can be shown in semi-industrial countries such as Sweden, where a surplus in prosperity can be largely ascribed to the smaller amplitude of her internal trade cycle. On the other hand, an agricultural country such as Australia showed a surplus during depression and a deficit during boom—a tendency somewhat damped by her lesser amplitude of fluctuation of internal income. Mining countries such as Chile show a surplus in booms and a deficit in depressions. Finally Canada, a special case, shows a pattern similar to that for the U.S.

These examples can only give a rough idea of the breadth of Dr. Chang's survey. Many other results are obtained, and they are, in general, in accordance with common-sense expectations and can be fitted into the economic history of the times without difficulty. The whole work, with the evidence which it constantly gives of skilful statistical estimation "behind the scenes", is in the tradition of Mr. Colin Clark.

But if one looks at it purely as an exercise in the treatment of statistics it takes on a much less attractive appearance. It is, of course, difficult to resist the temptation to argue from the past to the present (as I have suggested by using the present tense above), and fifteen years is a small jumping-off place for so large a jump. But Dr. Chang is hardly to be blamed for that; studies of the inter-war period are needed, even if that period is too short for our statistical purposes. It would have been convenient, too, if Dr. Chang had presented his basic statistical series (e.g., that for world real income) in an appendix, so that critics could try their hands at alternative calculations, but no doubt space was limited.

The real trouble is that there is no adequate discussion of the statistical problem of making inferences from short time periods; problems of significance, of multicollinearity and of autocorrelation, are passed by. Dr. Chang himself is not to be blamed for this—his book has been an unconscionable time in the press, and at the time it was written experts on the treatment of economic time series were very few, and readable books of instruction on the matter were then, as now, almost non-existent. Armed with up-to-date knowledge, the statistical purist will probably distrust almost all Dr. Chang's conclusions. He will be wrong, for the worst that can be said about them is that they are not "proved", or cannot be shown to be very highly probable, and that in many cases the data are not adequate to "prove" anything. But the conclusions will remain the most likely ones on the market, until someone with infinite (perhaps one should say, Chinese) patience works over the whole body of material again with new techniques.

C. F. CARTER.

7.—U.S. Bureau of the Census. *Handbook of Statistical Methods for Demographers*. By A. J. Jaffe. Washington: Govt. Printing Office, 1951. Prelim. ed. viii + 278 pp. 11s.

With the aim of improving the quality of the Censuses to be taken in 1950 in Latin American and other countries, the United States Census Bureau provided training courses for foreign students and technicians. Instruction was given for four months, and was followed by a period during which practical experience was gained on a specialized investigation. Attention was given principally to the administration and mechanics of enumerations, but it was thought desirable also to provide additional information as a background.

Accordingly, Dr. Jaffe was entrusted with the task of describing the processes of analysing population statistics. He gave a series of lectures, supplemented by laboratory exercises and a select reading list for the students to tackle. Afterwards it was decided to gather all this material into one volume for convenience, and the *Handbook* is the result. About two-thirds of it consists of reprints of articles and papers, thirty-one in number, from American actuarial, statistical and sociological journals, grouped under six headings, to which the lecture notes provide an introduction in each instance.

In a short and subsidiary course delivered to a group of foreign technicians, no doubt of varying standards of education, it would be difficult to give a thorough grounding in the science of demographic analysis, and no attempt was made to do this. Instead we find a restricted selection of subjects treated, in the lecture notes and particularly in the examples to be worked, in a fairly elementary manner. Thus the uses of life tables are described and illustrated; but there is little about the collection of mortality data or the theory of life table construction. Some methods for standardizing populations are given, but there are few warnings about the difficulties that may be experienced in interpreting the answers obtained from these procedures. There is a chapter on the making of population estimates which is necessarily restricted mainly to interpolations between censuses and to short-term projections, in the absence of a suitable opportunity to deal with the question of choosing mortality and fertility bases for projections of longer range.

The remaining chapters, which constitute about half the book, are concerned with assessing the accuracy of, and if necessary correcting, census returns, estimating the degree of completeness of birth and death registration and measuring migration from census and other statistics. These subjects are more appropriate in relation to the main courses for census technicians, and they are treated more fully in the *Handbook*. One feels that the average "student" might, on returning to his own country, cope satisfactorily with the problem of scrutinizing census and registration statistics; but attempts at life table construction or at the interpretation of standardized rates and proportions, encouraged by the partial instruction given, would probably be less happy.

For the reader outside America, it is useful to have in one place the reprints of articles that would otherwise have to be read piecemeal. Only slight inconvenience arises from the photographing of some of the contributions down the page and of others across the page, except where a diagram that was originally across the page is printed upside down by the second transformation. There are various misprints among the original material of the book, but this is described only as a preliminary edition and was clearly put together in a hurry. No doubt such matters will be put right at an early opportunity.

P. R. Cox.

8.—*United Nations Department of Economic Affairs. Economic Survey of Europe in 1950.* Prepared by the Research and Planning Division of the Economic Commission for Europe. Geneva, 1951. 263 pp. 11". 17s. 6d.

This is the fourth annual survey of the economic situation in Europe to be issued by the Economic Commission for Europe but the first one to be noticed in this *Journal*. It might be stated therefore that the E.C.E. was set up by the Economic and Social Council in 1947 and consists of all the European members of United Nations (including the three Soviet republics) together with the U.S.A. and its object is to facilitate concerted action for economic reconstruction to raise the level of economic activity and to strengthen economic relations. The annual survey is only one of many other publications of a statistical, economic or technical character.

The present volume forms a valuable and comprehensive account of Europe's economic position in 1950. After a discussion of the change in the world economic setting, the report analyses the changes in European production, the shortage of basic materials, international trade and payments and the problem of inflation. The authors estimate that world production rose 13 per cent. over 1949 and European production by 14 per cent.; in the eastern countries of Europe, however, and in the U.S.S.R. the increase is estimated at 22–23 per cent. They also estimate that the level of European industrial production in 1951 will, if the shortage of raw materials be overcome, also be of the order of 13 per cent. above 1950. Elaborate analyses of the foreign trade of different countries are given from which it is estimated that the terms of trade for Europe as a whole with all other countries deteriorated by nearly 30 per cent. since the 1949 pre-devaluation period. The most serious problem facing Europe in 1951 is, it is considered, inflation from the outside world. The report examines the different means open to countries in their efforts to maintain the value of money, suggests that these will prove inadequate and that only a general appreciation of European currencies and a return to a system of more flexible rates of exchange will solve Europe's present problem.

All the chapters are illustrated by a wealth of statistical material drawn primarily from national sources and worked up into aggregates and index numbers for Europe as a whole and its principal regions. Unlike, however, other and similar statistical publications, the authors of the survey have not hesitated to make estimates when official figures are lacking or to adjust official statistics to make them more uniform internationally, and considerable ingenuity is shown in many cases in adapting incomplete or incomparable data or in finding appropriate weights for combining national figures into European (or regional) aggregates. An appendix of 60 pages of notes on sources and methods purports to "explain in detail" the methods adopted and the adjustments made, but much more detail is required in some instances if the reader is interested in the methods adopted. Thus in Table 67 money wages in 1950 have been increased by 7 per

cent. in the United Kingdom and 35 per cent. in France "for family allowances, social insurance, paid holidays, etc." in order to arrive at comparable labour costs, but on referring to the notes to this table in the appendix the only information given on these percentages is that "allowance has been made for social benefits". Again, Table 69 attempts to show for ten countries the percentage of income paid in income taxes, central and local, by a married couple with two children having incomes of various multiples (3, 5, 10, 15, 20 . . . 100) of the "national income per head"; some of the figures seemed to the reviewer surprising, but the appendix gives merely a list of national sources on tax statistics and no information about national income per head. These tables, however, are "side lines"; for the main tables and calculations on production, foreign trade, balance of payments, etc., the methods are stated more fully. A considerable effort has been made to include information for eastern Europe, some of which, as the appendix shows, is not available in the usual statistical reference books but nevertheless, as the preface points out, "disproportionately little attention has been given to economic developments and problems" in these countries owing mainly "to the paucity of detailed information".

For a study of present economic developments in Europe and of probable future trends, this survey is indispensable.

J. W. NIXON.

9.—*Conference on Research in Income and Wealth. Studies in Income and Wealth. Volume 12.* New York: N.B.E.R., 1950. xiv + 585 pp. 9". \$6.

The Conference on Income and Wealth, held in 1948 by the National Bureau of Economic Research, was the first conference wholly devoted to wealth. In a previous discussion* of wealth Professor Kuznets analysed the methods of calculating national capital, and concluded that global estimates of national capital (which had been the only social account produced in the 19th century), were less useful for the purpose of economic analysis than estimates of national income. He suggested that future work on wealth should be in the field of "composition analysis", inquiries into the wealth of the business sector, of the distribution of wealth among private persons, and so on.

It would appear that Kuznets' advice was followed, for until 1948, problems of wealth estimation were neglected. During the war years national income estimates were greatly improved and extended, and each conference of the National Bureau of Economic Research was almost wholly devoted to their problems. After the war it became apparent that there were serious gaps in the existing social accounts, and that mistakes made in forecasting changes in the national income (for example, the effects of wartime backlog of demand for durable goods) were frequently due to inadequate knowledge about the national capital. A paper calling for estimates of wealth was presented by Professor Gainsborough to the 1946 conference.

The 1948 conference, stimulated by Gainsborough's paper, reversed the conclusions reached in 1938, and found estimates of the national capital to be of equal importance with those of national income. Global estimates were needed but they must be something more than those envisaged in 1938, which were totals reached by the substantive method (adding up the value of all wealth items) or by the claims method (adding up the value of claims to wealth). The global estimates needed in 1948 were of a national balance-sheet total. Both the assets and liabilities of the national balance-sheet were needed to give a clear picture of the national capital. A specimen balance-sheet was drawn up to guide contributors to the 1948 conference. It was realized that, as with global national income estimates, the supporting sector accounts would probably be of more interest than the global total, but that a global total was needed to show the relative importance of each sector to the whole and to each other.

The specimen balance-sheet was sent in advance to each contributor and two contributors undertook the task of surveying the whole field—Professor Goldsmith the assets, and Professor Hart the liabilities. Other contributors tried to make balance-sheet estimates of the various sectors of the economy—agriculture, including forest lands and subsoil wealth; manufacturing enterprises, including inventories; public utilities; consumers' tangible assets; Government wealth; and wealth overseas.

The programme was an ambitious one. The sector accounts give estimates, not all complete, of American wealth for the years 1929, 1939 and 1946. They are interesting in themselves, but the main value of Volume 12 should, perhaps, be judged by the extent to which it guides other wealth estimators in their work. The principles enunciated in the two overall surveys are very valuable for this purpose. Professor Goldsmith begins his study with a review of the functions of a national balance-sheet. He rightly points out the similarity with the functions of a firm's balance sheet. These are: to provide a continuous historical record of a firm's activities, to give the net profit for the period under review, and to indicate the firm's economic position. A national

* Kuznets, *On the Measurement of National Wealth*, N.B.E.R., Vol. 2, 1938.

balance-sheet should perform similar functions. The first function is, in fact, the same, and the second is very similar, but profit is replaced by a Pigovian concept of economic welfare. The author is ambiguous when he talks of the third function, that of evaluating the nation's economic position. He suggests that a firm's economic position can be shown by two documents (1) a liquidating balance sheet, and (2) an annual balance-sheet, where assets are regarded as unrecovered costs. A liquidating balance-sheet, he suggests, would lack meaning for a country—but he goes on to say that the nation's economic position is shown "by determining the total assets and the total net worth of all economic units that make up the community, primarily to the end of analysing asset composition, wealth distribution, and claim and liability interrelations". Net worth, however, can surely be found only through a liquidating balance-sheet. The author perhaps means that after all a nation also needs two balance-sheets, an aggregate balance-sheet made up of annual balance-sheets to determine total assets, and a liquidating balance-sheet, where claims and liabilities are offset, to find out the total net worth of all economic units.

Professor Goldsmith's distinction between national business accounting and national social accounting is useful. Statistical work in compiling the national balance-sheet must be based on business accounting. The ultimate aim must be to produce a social balance-sheet. It is imperative, however, that a balance-sheet based on accounting principles be produced first and afterwards adjusted to a social basis. A statistician told to produce a social accounting balance-sheet where marginal costs (taking into consideration marginal social costs) must be substituted for price, where capitalization factors for all assets must be modified to allow for the imperfections of the capital market and where the accounting unit must be one of stable purchasing power will be confronted with a hopeless task, since most of the factors to be taken into account are unknown. Professor Goldsmith is wise to insist on the necessity for a national balance-sheet where most of the factors to be taken into account are known.

In his discussion of the problem of asset valuation, Professor Goldsmith favours market price or a reasonably close approximation to it. The theoretically correct value of a capital good must be determined in terms of the expected flow of services from it—its "income flow", which must be discounted at the "appropriate" rate of interest. Market prices exist for many goods, especially if, as Professor Goldsmith suggests, a period of three months is used to determine the "market price". For assets which are never or rarely sold an approximation to market price can be assumed, based on depreciated replacement cost—which in practice is normally found by correcting balance-sheet values (original cost) by a price index of replacement costs. This approach was used by Dr. Kosh in his paper on "The Tangible Assets of Public Utilities", which he opens with a useful review of all existing valuation methods. Indeed throughout Volume 12 there can be seen an insistence on finding a suitable valuation method, rather than an emphasis on the "rightness" of one theoretical method and rejection of all others, as in 1938. In a world where the future cannot be foreseen and neither the income stream nor the "appropriate" discount rate can be estimated, it can be argued that it is only through the market that the determining factors can express themselves.

Professor Hart's breakdown of the connections between the wealth-claims structure and the current flow of activity into mechanical (logical) and motivating (empirical) relationships makes clear what relationships the economic statistician must look for in order to explain economic behaviour. Mechanical relationships illustrate flows, such as "the fact that net accretion of orders plus initial orders must equal orders on the books at the end of the period". In connection with wealth estimates these relationships give control data for estimating income. Motivating relationships are stated in "meaningful" propositions not inevitable in the light of definitions, and they are susceptible to refutation if research shows the effects were not as predicted", that is, they can be used for prediction. It may be that future work on estimating wealth will be judged by its ability to throw light on motivating relationships.

Volume 12 is an encouragement to wealth estimators. Kuznets' article in Volume 2 leaves the impression that wealth estimates are of little value in economic analysis, and that the theoretical difficulties of estimation are too great to allow adequate calculations to be made. Volume 12 more hopefully asserts the importance of national capital estimates and, while clearly recognizing their limitations, claims that some success in estimating them can be achieved on the basis of existing information.

KATHLEEN M. LANGLEY.

10.—*Scientific Method for Auditing*. By Lawrence L. Vance. Berkeley: University of California Press, 1950 (London: Cambridge University Press). xii + 108 pp. 9½". 19s.

This book is a publication of the Bureau of Business and Economic Research (University of California). The functions of the Bureau are confined to facilitating the prosecution of independent scholarly research by members of the faculty. It is made plain that the opinions expressed

in the book are those of the author and do not necessarily represent the views of the Research Bureau.

The book has the sub-title of "Applications of Statistical Sampling Theory to Auditing Procedure". In the preface the author states the aims of his study in the following manner:

"The object of this work is to make available to the accounting profession some of the techniques developed by statisticians for the interpretation of samples.

"Its method is to describe the use of probability inferences based upon the binomial distribution; to present sequential sampling as a basis for the general interpretation of auditing samples; to examine the conditions which auditing imposes upon statistical reasoning; to suggest specific procedures which will give auditing the benefit of objective statistical devices in the selection and interpretation of auditing samples or tests; to discuss their application; and to illuminate the bases thus provided for the establishment of objective, workable auditing standards".

For a proper understanding of the author's methods we must note that the term "probability" in the text has its mathematical meaning, i.e., "the ratio of certain events to all the possible events in a series or set".

It is accepted practice, due to the growth of commercial entities, that an auditor relies on sampling methods to determine the accuracy of the accounting data, and this procedure received the approval of the Committee on Auditing Procedure of the American Institute of Accountants in their publication *Extensions of Auditing Procedure*, which was released in May, 1939. If not impossible, it would be impracticable to prove each entry in the financial and related records of a large business.

If auditing is to be more than the application of routine practices, it is necessary that the basis on which the "population" is sampled should be determined on a tangible basis and not random choice. It is regrettable that many auditing programmes contain such instructions as "check any two months" or "vouch any one month". These directions indicate that the programme of work has not been settled by reference to any specific objective other than a coverage of various sectors of the audit. Auditing procedures in the United Kingdom have improved much since Dicksee's *Auditing* was published in 1892, but there are indications that too much reliance is being placed on the traditional approach, which the reviewer suggests might be improved by the introduction of new methods.

The reader of Professor Vance's work will not get much assistance in determining the manner best suited for selection of items for sampling. This choice must be made by the auditor, but since it is the kernel of the matter one would have wished that the subject received more detailed treatment. The practice of settling auditing programmes should not be undertaken without first reviewing the trend of operations. There are some who set up the monthly accounts in columnar form for each year to portray any trends which deserve special attention, e.g., increasing inventories, reducing sales. These are but obvious examples. To interpret these trends the auditor requires experience, and the ability to interpret financial statements and set them up in a simpler form than the conventional bases.

After the sample has been taken and the result summarized the auditor must decide if the margin of error disclosed is reasonable. What standards are to be applied in promoting this answer? Professor Vance suggests certain margins of acceptable error. These may not appeal to some accountants, who may prefer to base their judgment on the relationship of the item sampled to the overall financial picture.

The reader will be attracted by Professor Vance's suggestions for interpretation of samples taken. In this field he has made a useful contribution to auditing practice. The location of error may indicate further inquiry. Professor Vance gets this position in its proper perspective, but some may not concede the use of the application of statistical method. His tables are most advanced, and it is doubtful if there are many practising accountants sufficiently acquainted with statistical method to apply them. The majority of accountants would be content to set out their findings in a table drawn on the following or similar lines:

	Amount	%
Sampled	£ _____	100
Found correct	_____	_____
Found wrong	£ _____	100

This table has the merit of simplicity and can be compiled by a junior clerk. Moreover, it can be easily explained to a client if the necessity arises. The table will show the margin of error, and it is for the auditor to decide from this information if further inquiry is necessary.

The author's methods are more scientific, but the question of simplicity plays, rightly or wrongly, a part in determining programmes.

The reader should not assume that all auditing work on an engagement is dependent on samples. There are certain items in the accounts that should admit of no error. For example cash balances with banks should be precisely proved; accounts receivable should be lined up with the control accounts; accounts payable should be similarly proved and reconciled with creditors' statements.

If this work does no more than awaken the profession to the necessity for choosing samples scientifically and of interpreting their findings, it will have justified its preparation.

The author is Associate Professor of Accounting in the University of California, Berkeley, and his work is mainly directed to the American field, but accountants practising in the United Kingdom would do well to read his text.

It may be noted that recently the Society of Incorporated Accountants and Auditors removed the subject of statistics from their syllabus. It would be interesting to know why this was done.

T. KENNY.

11.—*Fundamentals of Governmental Accounting*. By Lloyd Morey and Robert P. Hackett. 2nd ed. New York: John Wiley and Sons (London: Chapman & Hall), 1951. xiii + 518 pp. 9½s. 44s.

This volume is a text-book of accountancy, which began its life under a different title in 1927, and assumed substantially its present form in 1942. It contains 174 pages of problems for the student, and a substantial, though "selected", bibliography; the latter contains such tempting items as "Executive Pre-audit of Encumbrances in Governmental Accounting", "Manual Street Sanitation Records", and "Accounting for Catholic Institutions of Higher Education". As these examples suggest, the book includes in its scope municipal, public utility and institutional accounts. Though thoroughly American in its method, it is not overloaded with references to peculiarities of United States practice, and it could no doubt be read with profit by a budding municipal accountant in this country. Indeed, it is a possible criticism of the book that it discusses accounting systems with such generality, and with so little reference to particular examples, as to be not a little dull. Nevertheless, it is perfectly clear, even to a lay reviewer, and it is no doubt an excellent instrument for imparting to the patient student a knowledge of standard approved systems of governmental accounting.

But the statistician who is looking for a work of reference on accounting principles in public finance, and the student with a taste for independent thought, will do well to look elsewhere. If one seeks, for instance, guidance on the treatment of depreciation, one finds:

"The entry of and accounting for depreciation on general governmental property is not essential. . . ." (p. 21.)

On page 31 we learn that it is not even desirable, because (a) it is not needed either as a basis for credit or as a means of discovering profit or loss; (b) the legal framework of a budget does not allow for making depreciation allowances or for accumulating them in funds; (c) "The chief item of interest and importance in connection with permanent property is its cost to the tax-payers".

The third of these is a mere assertion of what it is desired to prove; the second is irrelevant, for if the legal framework were wrong it would be the duty of accountants to propose changes in it. The plain fact is that a depreciation allowance is a rough and ready means of judging whether real capital is being run down, as well as a means of spreading the cost of its replacement over its life. Government bodies are large owners of real capital. The question of whether a depreciation allowance should be made is a practical one related, not to the type of owner of the property, but to the nature of the property itself. Thus, it may be proper to regard a bridge, once built, as everlasting and perpetually renewed by its annual maintenance; it would not be very sensible to take the same attitude to an expensive item of x-ray equipment in a public hospital.

But apparently accountants, in the United States as well as in Britain, regard the statement of an accountancy principle as an answer to all arguments, so that no discussion of the validity of the principle is required. At one point there is, indeed, a gleam of light:

"The use of the accrual basis in accounting for revenues and expenditures is recommended so far as practical. Revenues, partially offset by provisions for estimated losses, should be taken into consideration when earned, even though not received in cash. Expenditures should be recorded as soon as liabilities are incurred". (p. 29.)

But this is a quotation from a report of the National Committee on Municipal Accounting; and the authors' commentary on it leaves the reader in doubt as to what advice they would offer (for instance) to the British Treasury on this disputed matter. One would have hoped that a book on *fundamentals* would do more than lay down accepted and convenient principles; it would examine these principles in relation to those real purposes of which financial accountancy should be servant, not master. It can hardly be said that Professors Morey and Hackett have succeeded in this part of their task.

C. F. CARTER.

12.—*Domestic Utilization of Heating Appliances and Expenditures on Fuels in 1948/1949*. By Leslie T. Wilkins (The Social Survey). London: Central Office of Information, 1951. 56 pp. 13".

During recent years the Social Survey has collected a good deal of useful new information about domestic fuel consumption. Although current estimates of the total domestic expenditure necessitated by this consumption amount to nearly £400 million, and the need to secure the utmost economy in the use of fuel should by now be well appreciated, comparatively little statistical information has hitherto been available either about the precise amount of fuel consumed in domestic premises proper or about its method of utilization. Some of the inquiries made by the Social Survey in this field in recent years have been special investigations initiated by particular Government Departments and treated as confidential. At the request of the Department of Scientific and Industrial Research the Survey has recently re-examined the material collected during these investigations, and Mr. Wilkins' report now makes part of it available to the public.

The Social Survey is undoubtedly in possession of a mass of information about domestic fuel consumption which could enable it to prepare a more comprehensive report on this subject than the present one, and there is no doubt too that it could have issued more accurate figures and a more theoretically interesting document if it had been in a position to plan its inquiries throughout with publication in view, or, alternatively, to describe the methods of approach adopted in, and the full results obtained from, some of its special commissions. As the author points out, the way in which the present report has had to be prepared has inevitably led to shortcomings. It nevertheless contains much material of value.

The information is derived from a sample of 2,610 households in Great Britain, and from particulars, for a little over half of them, obtained from the supplying gas and electricity undertakings; it relates to the coal year 1948/1949. Distributions of the households in the sample are given so as to show the ownership of different types of appliance and the uses of each fuel. It seems that about 13 per cent. of households have gas and 14 per cent. have electricity, while 66 per cent. have both services and 7 per cent. have neither; only 1 per cent. of households do not make use of solid fuel. Large regional variations are shown in these figures, some of the causes of which are referred to, although the paucity of the data is said to prohibit a statistical elucidation of all the inter-relationships concerned. The marked increase in recent years in part-time space-heating—particularly by the portable electric fire—is also shown. Expenditures on each type of fuel are analysed to display the relationship between them and differences in income, rateable value, number of rooms occupied, rural or urban location and size of family. It is interesting to note the higher income elasticity of electricity than of gas expenditure and, because of the two-part tariff, the higher average cost of current to the poorer income groups.

G. H. DANIEL.

STATISTICAL NOTES

BRITISH OFFICIAL STATISTICS

The interim index of retail prices compiled by the Ministry of Labour and National Service rose from 125 in June to 126 in July, and 127 in August. The increase was due mainly to higher prices for meat, to small increases for many articles of clothing, furniture and household appliances and to higher prices for admission to cinemas.

The detailed figures for the three months were as follows:

(Prices at June 17th, 1947 = 100)

Date	Food	Rent and Rates	Clothing	Fuel and Light	House- hold Durable Goods	Miscel- laneous Goods	Services	Drink and Tobacco	Total
Weights:	348	.88	97	65	71	35	79	217	1,000
June 19th	135.9	103.8	138.6	125.6	134.2	130.4	116.8	106.8	125
July 17th	139.8	103.9	140.7	127.5	135.0	131.6	117.2	106.8	126
Aug. 14th	139.7	103.9	142.7	127.8	137.6	132.1	120.3	106.8	127

In publishing the figures, the Ministry of Labour states that they are in the form in which they are used in the procedure adopted for calculating the index for all the groups combined, i.e., to the nearest first place of decimals. The decimals are shown in order that, if desired, calculation can be made of the effect of combining particular groups and excluding others. The information available as to price changes, however, is such that no precise significance can be attached to the decimals, and for any other purpose, therefore, the figures should be used to the nearest whole number.

The Ministry of Labour index of weekly wage rates, which was 119 (June, 1947 = 100) in June rose to 120 in July and August. The increases affected mainly workers in the retail drapery, outfitting and footwear trades, printing, wool textiles, iron and steel manufacture, electricity supply and boot and shoe manufacture.

The six-monthly enquiry into average earnings showed that in April, 1951, the average weekly earnings in the industries covered by the Ministry of Labour returns were 160s. 2d. for men, 66s. 11d. for youths and boys, 87s. 4d. for women and 55s. 11d. for girls. These figures represented increases over October, 1938, of 132, 157, 169 and 202 per cent. For all workers combined the average was 136s. 2d., 156 per cent. more than in 1938. The index number for April, 1951, compared with 100 at April, 1947, was 132. The average weekly hours worked continued to rise slightly and, at 46.3, were only 0.2 hours less than in October, 1938, when the normal hours of work were commonly 47 or 48, as against 44 and 45 in April, 1951.

The total working population in Great Britain and the numbers in civil employment at recent dates, compared with mid-1948, when the new series of man-power figures started, have been as follows:

	Total Working Population			Numbers in Civil Employment			Thousands
	Males	Females	Total	Males	Females	Total	
Mid-1948	15,810	7,094	22,904	14,698	6,986	21,684	
May, 1951	15,938	7,351	23,289	14,998	7,260	22,258	
June, "	15,952	7,375	23,327	15,015	7,289	22,304	
July, "	15,966	7,400	23,366	15,023	7,318	22,333	

The level of unemployment fell in July, but rose slightly in August owing largely to the registration of boys and girls who left school at the end of the summer term. The figures are analysed below:

*Number of Unemployed Persons on the Registers of the Employment
Exchanges of the Ministry of Labour and National Service*

Date	Men and Boys	Women and Girls	Total
June 18th, 1951	125,463	65,313	190,776
July 16th, 1951	122,452	63,395	185,847
August 13th, 1951	132,886	71,998	204,884

The figures do not include registered severely disabled persons who are unlikely to obtain work other than under special conditions.

It is estimated that the number of unemployed persons on the registers at August 13th represented 1.0 per cent. of the total number of employees insured under the national insurance schemes. The percentage in the Regions ranged from 0.3 in the North Midlands and 0.4 in the Midlands to 1.9 in the Northern area, 2.1 in Scotland and 2.3 in Wales.

The number of insured persons absent from work owing to sickness, including self-employed as well as employed, was 805,900 in June, 768,700 in July and 766,900 in August. All these figures were lower than in the corresponding months of 1950. The number of employed persons absent owing to industrial injuries was 57,900 in June, 57,500 in July and 55,500 in August.

The *Preliminary Report* on the fifteenth Census of England and Wales which has recently been issued by the Registrar General does not differ appreciably in content from previous reports of this kind. It contains a short discussion of the administrative set-up of the Census, together with tables prepared from the abstracts of local Census officers, showing the populations, divided by sex, of different administrative areas down to the level of urban and rural districts. The fifteenth Census did not differ from its predecessor in administrative arrangement, but it is welcome news that the Registrar General intends to publish an analysis of a 1 per cent. sample of the household schedules within a year of enumeration. This will reduce the gap between enumeration and publication of the results, which has frequently detracted from the value of the Census figures.

Two entirely new questions were asked at the 1951 Census. The first related to the age at which full-time education had ceased, but unfortunately this question was restricted to the gainfully occupied portion of the population. It is difficult to see the reason for this restriction. The analysis would not have been very much more complex had this question applied to the entire adult population, and the restriction means that information on the educational status of women in particular will be defective. If this question is to be repeated in future censuses it is to be hoped that the restriction will disappear, for the material collected will be of immense value to the sociologist, especially if data relating to the educational status of husbands and wives could be published in a bivariate table.

The second new question inquired whether the household had the use, joint or exclusive, of a cooking stove or range, water closet, sink and fixed bath. The answers should supplement the information generally given in the housing returns.

The total population enumerated at the Census was 43,744,924 persons, 48.1 per cent. of whom were males and 51.9 per cent. females. The figures below show the development of the

Year	Population (Millions)	Per cent. Females	Decennial Rate of Growth (per cent.)		
			Excess of Births over Deaths	Net Migration	Total
1901	32.5	51.6	—	—	+10.89
1911	36.1	51.6	+11.41	-0.52	+ 4.93
1921	37.9	52.3	+ 8.18	-3.25*	+ 5.53
1931	40.0	52.1	+ 5.99	-0.46	+ 4.65
1951	43.7	51.9	+ 4.03	+0.62*	

* Including deaths overseas of service personnel.

population during the present century together with the intercensal rates of growth. It will be seen that the decennial rate of increase of 4.65 per cent. which has been experienced between 1931 and 1951 is the lowest during the present century, and indeed the lowest recorded since censuses began in 1801. The decline in the natural rate of increase is even more spectacular, as the period 1931-51 is the first to show a positive net migration balance.

The geographical distribution of the population has also changed appreciably. In the standard regions of the Registrar General, five, the Northern, North-Western, Wales, London and East and West Riding, showed a net loss by migration between 1931 and 1951. The loss in London

Region	Population (Millions)		Per cent. Total		Rate of Growth		
	1931	1951	1931	1951	Nat. Incr.	N.M.	Total
Northern	3.04	3.14	7.6	7.2	+10.3	- 6.9	+ 3.3
E. and W. Riding	3.93	4.10	9.8	9.4	+ 7.6	- 3.4	+ 4.2
North West	6.20	6.45	15.5	14.7	+ 6.0	- 2.1	+ 4.0
North Mid.	2.94	3.38	7.4	7.7	+11.2	+ 3.8	+15.0
Midland	3.74	4.42	9.4	10.1	+13.1	+ 5.0	+18.1
Eastern	2.43	3.10	6.1	7.1	+ 9.1	+18.1	+27.2
London and S.E.	10.33	10.90	25.9	24.9	+ 7.3	- 1.8	+ 5.5
Southern	2.14	2.65	5.3	6.1	+ 9.0	+15.0	+24.1
South West	2.61	3.02	6.5	6.9	+ 5.2	+10.4	+15.5
Wales	2.59	2.60	6.5	5.9	+ 6.9	- 6.7	+ 0.1
E. and W.	39.95	43.75	100.0	100.0	+ 8.2	+ 1.3	+ 9.5

took place entirely in the period 1939 to 1951. The County of London has, of course, decreased in population steadily since 1901, but the area known as Greater London, which now has a population of 8,346,000 against 8,216,000 in 1931, was estimated to contain 8,728,000 persons at the middle of 1939. Nine of the ten counties showing the largest intercensal rates of increase, however, are located around London and in the south-east, and it will be interesting to see whether there has been a tendency for Londoners to move out of the area known as Greater London, to the relatively more rural home counties, while continuing to work in Greater London. This problem will have to await its answer until the information on places of work has been analysed.

A new feature of the preliminary report is a table giving the population of six major conurbations: Greater London, Merseyside, South East Lancashire (Manchester and District), West Midland (Birmingham and District) West Yorkshire (Leeds and District) and Tyneside. These six major centres of population accounted for nearly 17 million persons, or 38.7 per cent. of the population. It is noteworthy that the proportion living in these areas was 41.1 per cent. in 1931 and 40.4 per cent. in 1921. The tendency to move away from large centres of population is not confined to the London area. The figures below show that the proportion of the population who live in large cities has been declining since 1921, and that the decline has now reached cities of over 100,000 inhabitants. It is doubtful whether these figures mean that the population in urban

Proportion of the Population Living in Towns with more than a Specified Number of Inhabitants

	Over 500,000	Over 200,000	Over 100,000
1921	19.7	29.4	40.0
1931	18.9	29.0	40.0
1951	15.9	24.6	38.4

Note.—These figures relate to County Boroughs, Municipal Boroughs and Urban Districts, but the County of London has been included, as it is in effect a County Borough.

areas has actually declined. They may merely reflect the increasing urbanization of fringes of larger towns which are still officially classified as rural districts. Very few local government boundary changes have taken place since 1939, and the old boundaries may in some cases have little meaning as dividing-lines between town and country.

1951]

CURRENT NOTES

There has recently been formed in North Israel an Association of Economists and Statisticians. The first meeting was held last August when Professor Bacchi, the Government Statistician, gave an address on "The Position of Statistics in the State To-day." The audience, numbering about 30, was representative of Government, industry and commerce.

The provisional Committee is hoping to establish one or more Study Groups and possibly a library. The Secretary is Mr. Ramond V. Baron of 19, Rehov Harakafot, Tivon, near Haifa, Israel.

We extend to the Association our best wishes for its successful development.

The Trustees of the Houblon-Norman Fund invite applications for Fellowships or Grants in aid of research into the working of financial and business institutions in Great Britain and elsewhere and the economic conditions affecting them.

Apart from exceptional cases, awards will be confined to British-born subjects normally resident in the United Kingdom and will take effect from October 1st, 1952. Fellowships will be awarded for one year, renewable for a second year: and the amount of all awards will depend upon the circumstances of the candidate and the likely expenses of his work.

Applications should be made not later than March 31st, and forms of application may be obtained from the Secretary of the Fund (W. M. Allen), c/o Bank of England, London, E.C.2.

STATISTICAL AND ECONOMIC ARTICLES IN RECENT PERIODICALS

UNITED KINGDOM—

Accounting Research—

July 1951—The effects of the Local Government Act, 1948, and other recent legislation on the finances of local authorities: *A Research Working Party*. Source and use of funds in the motor industry: *J. A. Stewart*. A national balance sheet: *F. Sewell Bray*. Towards a multi-dimensional accounting system: *H. S. A. Macnair-Smith*. The economic consequences of business accountancy—the need for research: *C. C. Potter*.

Agricultural Economics Society, Journal of Proceedings—

July 1951—Principles of valuation of land and farms: *D. K. Britton*. Rural planning: an index of social provision: *H. E. Bracey*.

British Journal of Sociology—

September 1951—Social administration in a changing society: *R. M. Titmuss*. Primary social attitudes as related to social class and political party: *H. J. Eysenck*. Social status and social structure: *S. M. Lipset* and *R. Bendix*. Social conditions and the labour vote: *W. George*.

Economica—

August 1951—The distribution of incomes and the burden of estate duties in the United Kingdom: *E. C. Rhodes*. Decreasing costs and the gains from trade: *E. Coen*. National income, exchange rates and the balance of trade: a note: *W. Beckerman*. A note on the effect of income redistribution on aggregate consumption with interdependent consumer preferences: *H. G. Johnson*.

Economic Journal—

June 1951—Twenty years on: a survey of the theory of the multiplier: *G. L. S. Shackle*. Notes on trade cycle theory: *R. F. Harrod*. Home and export trade: *H. P. Barker* and *R. F. Kahn*. South Africa's balance of payments and the sterling area, 1939–50: *N. N. Franklin*. Passenger road transport and the Transport Act 1947, with particular reference to the north-east of England: *A. M. Milne*. A note on "Risk and the cobweb theorem": *P. K. Newman*. The economic position of the bordars and cottars of Domesday Book: *R. Lennard*.

Oxford University Institute of Statistics, Bulletin—

July 1951—The accuracy of pre-election polls: *H. Field*. Some notes on engineering earnings: *K. G. J. C. Knowles* and *D. J. Robertson*.
August 1951—Household expenditure in France and in England: *T. Schulz*. Cost curves for gas supply: *K. S. Lomax*. International equilibrium and U.S. private investment: *T. Balogh*.

Population Studies—

July 1951—Some lesser known French demographers of the eighteenth century: *de la Morandière*, *de Caveirac*, *Cerfvol* and *Pinto*: *A. Sauvy*. Population distribution and growth in Africa: *L. T. Badenhorst*. Social class differences in health and survival during the first two years of life; the results of a national survey: *J. W. B. Douglas*. Regional differences in reproductivity in England and Wales: *C. Clark*. The constancy of local populations and migration in England before 1800: *E. J. Buckatzsch*. A note on the under-registration of births in Britain in the nineteenth century: *D. V. Glass*.

Review of Economic Studies—

Vol. XVIII (2), No. 46—Optimum pricing as applied to telephone service: *A. Hazlewood*. The gains from limited trade: *F. C. Child*. Reserve capacity and the kinked demand curve: *P. Streeten*.

1951]

593

AUSTRALIA—

Economic Record—

June 1951—Deliberate saving and the consumption function: *H. W. Arndt* and *J. R. Wilson*. New Zealand's export supply function: *A. R. Bergstrom*. Some recent developments in the sterling area: *J. O. N. Perkins*. Recent trends in Australian fertility: *R. J. Linford*. The employment problem in pre-classical English economic thought: *N. J. Pauling*.

INDIA—

Sankhyā—

March 1951—On the realization of stochastic processes by probability distribution in function spaces: *H. B. Mann*. A theorem in least squares: *C. R. Rao*. On type B₁ and type B₂ regions: *H. K. Nandi*. Some notes on ordered samples from a normal population: *K. C. S. Pillai*. Some exponential forms for topographic correlation: *B. Ghosh*. On the orthogonal polynomials associated with Student's distribution: *A. S. Krishnamoorthy*. A multivariate gamma-type distribution: *V. K. Ramabhadran*. A study on differences in physical development by socio-economic strata: *R. Mukherjee*. Railway statistics: *J. Singh*.

UNITED STATES—

American Academy of Political and Social Science, Annals—

July 1951—Lessons from Asia (whole number).

American Statistical Association Journal—

June 1951—Response errors in surveys: *M. H. Hansen*, *W. N. Hurwitz*, *E. S. Marks* and *W. P. Mauldin*. A critical analysis of farm employment estimates: *D. G. Johnson* and *M. C. Nottenburg*. Estimating parameters of logarithmic-normal distributions by maximum likelihood: *A. C. Cohen, Jr.* Recent mortality trends and differentials: *I. M. Moriyama*. On the variance of estimates of the standard deviation and variance: *W. D. Evans*. Transformation functions in the theory of production indexes: *P. B. Simpson*. Sampling 1949 corporation income tax returns: *A. C. Rosander*, *R. H. Blythe, Jr.*, and *D. E. Johnson*.

Annals of Mathematical Statistics—

June 1951—Consistency and unbiasedness of certain nonparametric tests: *E. L. Lehmann*. A significance test for exponential regression: *E. S. Keeping*. On the duration of random walks: *W. Wasow*. On the theory of unbiased tests of simple statistical hypotheses specifying the values of two or more parameters: *S. L. Isaacson*. Designs for two-way elimination of heterogeneity: *S. S. Shrikhande*. Generalized hit probabilities with a Gaussian target: *D. A. S. Fraser*. Estimation of parameters in truncated Pearson frequency distributions: *A. C. Cohen, Jr.* On the distribution of the characteristic roots of normal second-moment matrices: *A. M. Mood*. A bivariate extension of the *U* statistic: *D. R. Whitney*. Relations between variously defined effects and interactions in analysis of variance: *S. Vajda*. On uniformly consistent tests: *A. Berger*. Non-parametric estimation IV: *D. A. S. Fraser* and *R. Wormleighton*. Conditional expectation and the efficiency of estimates: *P. G. Hoel*. Linear transformations and the product-moment matrix: *K. Nagabhushanam*. A note on a two sample test: *F. J. Massey*. An omission in Norton's list of 7×7 squares: *A. Sade*. Relations between moments of order statistics: *R. H. Cole*.

Biometrics—

June 1951—A re-examination of Rahn's data on the number of genes in bacteria: *D. J. Finney* and *L. Martin*. Rectangular lattices and partially balanced incomplete block designs: *K. R. Nair*. Notes on the estimation of gross and net reproduction rates by methods of statistical sampling: *J. C. Koop*. The use of systematic 5×5 squares: *Ø. Nissen*. The effect of sulfamerazine on the erythrocyte and hemoglobin content of trout blood: *J. S. Gutsell*. Sur une application de la statistique mathématique à la biologie: *M. Fréchet*. Relationships among characters observed in urea clearance tests: *H. Fairfield Smith*. On the errors of biological assays with graded responses, and their graphical derivation: *N. T. Gridgeman*.

Econometrica—

July 1951—Jevons and his precursors: *R. M. Robertson*. Optimal inventory policy: *K. J. Arrow*, *T. Harris* and *J. Marschak*. The coefficient of resource utilization: *G. Debreu*. A formal theory of the employment relationship: *H. A. Simon*. A note on dynamic multipliers: *R. Solow*. Note on the inversion of the Leontief matrix: *J. L. Holley*.

Journal of Experimental Education—

March 1951—The association of mathematical achievement with certain factors resident in the teacher, in the teaching, in the pupil and in the school: *J. Schumert*. The symmetrical idempotent matrix in factor analysis: *C. W. Harris*. The inductive-deductive compared to the deductive-descriptive approach to laboratory instructions in high school chemistry: *C. H. Boeck*. A comparison between the matched groups and the covariance techniques: *M. D. Engelhart*. Curve fitting in polar coordination: *W. H. Desmond*. Teacher morale and curriculum development: a statistical analysis of responses to a reaction inventory: *W. E. Coffman*. Practices associated with effective discipline: a descriptive statistical study of discipline: *S. L. Celler*.

Mathematical Tables and other Aids to Computation—

July 1951—Monte Carlo matrix calculation with punched card machines: *A. Opler*. Computing logical truth with the California Digital computer: *W. R. Abbott*. On the accuracy of Runge-Kutta's method: *M. Lotkin*.

Psychometrika—

June 1951—A general solution for the latent class model of latent structure analysis: *B. F. Green, Jr.* Time-limit tests: estimating their reliability and degree of speeding: *L. J. Cronbach* and *W. G. Warrington*. Optimal test length for maximum battery validity: *P. Horst*. Remarks on the method of paired comparisons: II. The effect of an aberrant standard deviation when equal standard deviations and equal correlations are assumed: *F. Mosteller*. Rate of addition as a function of difficulty and age: *J. E. Birren* and *J. Botwinick*. A mechanical model illustrating the scatter diagram with oblique test vectors: *H. Gulliksen* and *L. R. Tucker*. A graphical method for the rapid calculation of biserial and point biserial correlation in test research: *H. W. Goheen* and *M. D. Davidoff*.

Review of Economics and Statistics—

May 1951—Schumpeter, social scientist (whole number).

FRANCE—

Population—

April-June 1951—La mortalité des vieillards: *P. Vincent*. Le problème démographique au Japon: *J. Robin*. La mesure de la mortalité infantile. I. Principes et méthodes: *J. Bourgeois-Pichat*. Les anomalies des lois sur la nationalité: doubles nationaux et apatrides: *M. Loisel*. La population vue par les utopistes: *H. Bergues*. Niveau de vie des familles suivant le nombre d'enfants: *F. Tabah*. Progrès des études de population au Brésil: *A. Page*.

ITALY—

Giornale degli Economisti e Annali di Economia—

January-February 1951—La contabilità nazionale come strumento di politica economica: *L. Lenti*. La dimensione del tempo nella misura del risparmio: *A. D. Montgomery*. Matematica Finanziaria ed Economia: *E. Zaccagnini* and *E. Levi*. La composizione economica e professionale della popolazione di Venezia nei secoli XVII e XVIII: *D. Beltrami*.

May-June 1951—G. B. Antonelli, economista matematico ignorato: *G. Demaria*. Sulla teoria matematica dell'economia politica: *G. B. Antonelli*. Commento alla memoria di G. B. Antonelli dell'anno 1886: "Sulla teoria matematica della Economia politica": *G. Ricci*. Ancora di alcuni procedimenti minimizzanti il costo di certi trasporti, in relazione alla teoria della localizzazione delle industrie del Weber: *L. Galvani*.

1951]

POLAND—

Studia I Prace Statystyczne—

Vol. I, Part 1—Statistics in the Soviet Union: *A. Weryha*. National Census 1950: *Z. Padowicz*. Remarks in regard to the investigation of dwelling conditions within the framework of the 1950 National General Census: *W. Morawski*. Project of a sample survey of the census material: *M. Fisz*. More about the sampling method as applied to the returns of the General Census: *S. Szulc*. Statistics and planning: *B. Minc*.

Vol. I, Part 2—Statistical evaluation method: *H. Steinhaus*. Sampling inspection by attributes: *J. Oderfeld*. Quality control of mass production by variates: *M. Fisz*. (Text in Polish—English summaries.)

SWEDEN—

Acta Agriculturae Scandinavica—

1951—The human factor and success in farming: *N. Westermarck*.

Skandinavisk Aktuarietidskrift—

Vol. 1-2 1951—On asymptotic expansions of probability functions: *H. Bergström*. Concerning some inequalities in the theory of statistical estimation: *E. W. Barankin*. Truncated inverse binomial sampling: *M. Sandelius*. A function for smoothing tables of the duration of sickness: *K. Medin*. The regression problem involving non-random variates in the case of stratified sample from normal parent populations with varying regression coefficients: *M. Weibull*.

INTERNATIONAL—

Social Research—

June 1951—Jewish population trends in the United States: *C. N. Rosenquist* and *S. T. Friedman*.

International Labour Review—

June 1951—Economic problems and reconstruction in Italy: *I. A. Capanna*. Australian development and immigration: *Sir D. Copland*. Employment of married women and mothers of families.

LIST OF ADDITIONS TO THE LIBRARY

Since the issue of Part III, 1951, the Society has received the publications enumerated below.

I.—OFFICIAL PUBLICATIONS

(a) United Kingdom

Advisory Council on Scientific Policy

Fourth annual report of the Advisory Council on Scientific Policy (1950–1951). London, H.M.S.O., 1951. Cmd. 8299. 17 pp. 9½". 9d.

Government scientific organisation in the civilian field. London, H.M.S.O., 1951. 47 pp. 9½". 1s. 6d.

Central Land Board. Report of the Central Land Board for the financial year 1950–51. London, H.M.S.O., 1951. 18 pp. 9½". 9d.

Education, Ministry of. Education in 1900–1950. The report of the Ministry of Education and the statistics of public education for England and Wales for the year 1950. London, H.M.S.O., 1951. Cmd. 8244. xii, 250 pp. illus. 9½". 7s. 6d.

General Register Office

Census 1951 England and Wales: preliminary report. London, H.M.S.O., 1951. xxiii, 52 pp. 13". 5s.

Hospital morbidity statistics: a preliminary study of in-patient discharges; by Donald Mackay ... with a foreword by Sir John Charles ... London, H.M.S.O., 1951. 113 pp. 9½". 3s. 6d. (Studies on Medical and Population Subjects 4.)

Home Office. Offences relating to motor vehicles. London, H.M.S.O., 1951. 41 pp. 9½". 1s. 3d.

Inland Revenue, Board of. Estate duty and family businesses. London, H.M.S.O., 1951. Cmd. 8295. 9 pp. 9½". 6d.

Labour and National Service, Ministry of. Interim report of the cost of living advisory committee. London, H.M.S.O., 1951. Cmd. 8328. ii, 7 pp. 9½". 6d.

Materials, Ministry of. Plan of reserve prices for wool: origin, history and operations of the existing joint organisation. (U.K.-Dominion Wool Disposals Ltd.) London, H.M.S.O., 1951. Cmd. 8329. 18 pp. 9½". 9d.

Medical Research Council

The application of scientific methods to industrial and service medicine. (Proceedings of a Conference held from March 29th to March 31st, 1950.) London, H.M.S.O., 1951. 112 pp. 9½". 3s.

Studies of undernutrition, Wuppertal 1946–9, by members of the Department of Experimental Medicine, Cambridge, and associated workers. London, H.M.S.O., 1951. xiv, 404 pp. illus. 9½". 12s. 6d. (Special Report series 275.)

Thyroid enlargement and other changes related to the mineral content of drinking water (with notes on Goitre Prophylaxis) by Margaret M. Murray, J. A. Ryle, Beatrice W. Simpson and Dagmar C. Wilson. London, H.M.S.O., 1948. 39 pp. 9½". 1s. 6d. (Medical Research Council, Memorandum, 18.)

Scotland. Census Office. Census of Scotland 1951: preliminary report on the fifteenth census of Scotland. Edinburgh, H.M.S.O., 1951. xiv, 47 pp. 13". 3s.

Social Survey

Children out of school; by Joy C. Ward: an inquiry into the leisure interests and activities of children out of school hours carried out for the Central Advisory Council for Education

1951]

- (England) in November-December, 1947. London, Central Office of Information, 1948. ii, 76 pp. 13".
- Consumer expenditure series. Expenditure on hairdressing, cosmetics, and toilet necessities; by W. F. F. Kemsley and David Ginsburg ... London, C.O.I., 1951. 16 pp. 13".
- Trade, Board of.* A statement on resale price maintenance: being a trade practice which prevents shopkeepers from reducing certain prices to the public. London, H.M.S.O., 1951. Cmd. 8274. 11 pp. 9½". 6d.
- Treasury.* Control of dividends. London, H.M.S.O., 1951. Cmd. 8318. 3 pp. 9½". 3d.

(b) Other National and International Publications

Australia

- Bureau of Agricultural Economics.* Merino wool growing: comparative study of costs, returns and profitability of breeding and wether running in the Armidale District, N.S.W. (1946-49). Canberra, 1951. 22 pp. 9½".
- Bureau of the Census and Statistics.* Census of the Commonwealth of Australia 30th June, 1947. Part xii.—Birthplace. Part xiii.—Period of residence in Australia of persons born outside Australia. Canberra, 1951. 2 vols. 13". 2s. 6d. each vol.

Ceylon

- Department of Census and Statistics.* Census of Ceylon 1946, Vol. I, Part II—Statistical digest; by A. G. Ranasintha ... Colombo, 1951. xviii, 424 pp. 10¾".

Denmark

- Det Statistiske Departement.* Det Statistiske Departement 1920-1950. Copenhagen, 1951. 153, vi pp. 9". 3 Kr. (Statistiske Meddelelser, 4, 139, 4.)

France

Institut National de la Statistique et des Études Économiques

- L'espace économique Français. Richesse-Population-Production-Revenus-Niveau de vie—par départements. Paris, 1951. 144 pp. maps. 10¾". 1000 f. (Études et conjoncture, Économie française, Numéro special.)
- Quelques aspects fondamentaux de l'économie mondiale. Paris, 1951. 340 pp. 10½". 1000 f. (Études et conjoncture, Économie mondiale, Numéro special.)

Germany

- Statistisches Bundesamt.* Statistik der Bundesrepublik Deutschland, 12, 13, 14. Handwerkszählung vom 30.9.1949. Band 2 ... Bundesgebiet, Schleswig-Holstein, Hamburg, Niedersachsen, Nordrhein-Westfalen, Bremen. 304 pp. Band 3. Hessen, Württemberg-Baden, Bayern, Rheinland-Pfalz, Baden, Württemberg-Hohenzollern, Kreis Lindau. 335 pp. Band 4. Beschäftigte nach Stellung im Betrieb und Umsatz im Handwerk. 163 pp. — 18. Die kommunalen Finanzen im Rechnungsjahr 1949, Teil 1. 173 pp. — 32. Alphabetisches Gemeindeverzeichnis für die Bundesrepublik Deutschland. Vorläufiges Ergebnis nach der Volkszählung vom 13.9.1950. Wiesbaden, 1951. 5 vols. 133 pp. 11¾".

Norway

Statistisk Sentralbyrå

- Fiskeritelling 1 oktober 1948. 251 pp. (N.O.S. xi, 62.)
- Fortegnelse over Norges Offisielle Statistikk 1828-1950. 97 pp. (N.O.S. xi, 63.)
- Statistisk Sentralbyrå gjennom 75 år. Tre 25-årsmeldinger. 53 pp. (N.O.S. xi, 65.)

Spain

Instituto Nacional de Estadística

- Censo de la población de España de 1940 ... Tomo I (Cifras generales). 1943. xcix, 330 pp. lxxvi pp. 10¼".
- Censo de la población de España, según la inscripción de 31 de diciembre de 1940. Resúmenes por regiones y nacionales de las clasificaciones por sexo, edad, estado civil, instrucción

- elemental, fecundidad y profesion de la población presente (Hecho). Madrid, n.d. [669 pp.] various paging. 10½".
- Conferencias de preparacion matematica y estadistica por Francisco Azorin Poch, Sixto Rios Garcia, Enrique Maceda, Angel Anos y Dias de Arcaya. 1950. xi, 186 pp. 9½".
- Movimiento natural de la población de España. Año 1946. Año 1947. Año 1948. Año 1949. Madrid 1948-1951. 4 vols. 10¼".

United Nations

Department of Economic Affairs

- Budgetary structure and classification of government accounts. New York, U.N.O. (London, H.M.S.O.). iv, 100 pp. 9". 5s. (1951, xvi, 3.)
- Public finance information papers. Colombia. 41 pp. 1s. 6d. (1951, xvi, 8.) Egypt. 31 pp. 1s. (1951, xvi, 7.) Iran. 102 pp. 3s. 9d. (1951, xvi, 4.) Iraq. 43 pp. 1s. 9d. (1951, xvi, 6.) Italy. 80 pp. 3s. (1951, xvi, 9.) New York, U.N.O. (London, H.M.S.O.). 5 vols. 10½".
- Review of economic conditions in the Middle East. Supplement to the World Economic Report 1949-50. New York, U.N.O. (London, H.M.S.O.). 84 pp. map. 11". 7s. 6d. (1951, II, C.3.)
- World economic report 1949-50. New York, U.N.O. (London, H.M.S.O.). xii, 247 pp. 11". 17s. 6d. (1951, II, C.1.)
- Statistical Office. Report on the Inter-American seminar for biostatistics, held at Santiago, Chile from 25 September to 15 December 1950 ... New York, U.N.O. 43 pp. 10½". (Statistical papers M.9.)

United States of America

- Department of Commerce. Office of Business Economics. National income and product of the United States, 1929-1950; prepared by the National Income Division ... 1951 ed. Washington, Govt. Printing Office, 1951. vi, 216 pp. 11¼". \$1. (Supplement to the Survey of Current Business.)

Yugoslavia

- Statisticki ured Narodne Republike Hrvatske. Administrativno-teritorijalna podjela i imenik naseljenih mjesta narodne Republike Hrvatske. Stanje 1 v 1951. Belgrade, 1951. [viii], 347 pp. map. 11¼".

II.—AUTHORS AND MISCELLANEOUS

- ADAM (A.). Statistisches Qualitätskontrolle und industrielle Forschung. *Mitteilungen ÖKW* (1950), Heft 1-2. 5 pp. 11¼".
- ANDERSON (R. L.) & MANNING (H. L.). An experimental design used to estimate the optimum planting date for cotton. *Biometrics* (1948), 4, 171-198. 9¼".
- BARTLETT (M. S.). A further note on tests of significance in factor analysis. *Brit. J. Psychol. Statist. Sect.* (1951), 4, 1. 9¼".
- An inverse matrix adjustment arising in discriminant analysis. *Ann. Math. Statist.* (1951), 22, 107-111. 10".
- BEARE (J. MARTIN) & CHEESEMAN (E. A.). A localized outbreak of tinea capitis (*M. Audouini*) in Northern Ireland. *Arch. Dis. Childh.* (1951), 26, 149-157. 9¼".
- Tinea capitis: review of 1,004 cases. *Brit. J. Dermatology* (1951), 63, 165-186. 9¼".
- BECK (G. M.). A survey of British employment and unemployment, 1927-1945. Oxford Univ. Institute of Statistics, 1951. 83 pp. 4 append. tables. 13". 20s.
- BENNETT (L. G.). Financial results on 34 fruit and market garden holdings in the southern province 1948-1949. Univ. of Reading, Dept. of Agricultural Economics, 1950. 5 pp. 8" x 13".
- BOLDRINI (MARCELLO). O homem e a sociedade: introdução ao estudo biométrico do homem; tradução de Valerio Mortara. Rio de Janeiro, Instituto Brasileiro de Geografia e Estatística, 1950. [ii], 125 pp. 10¼".
- BROOKES (B. C.) & DICK (W. F. L.). Introduction to statistical method ... Parts I and II. London, Heinemann, 1951. viii, 288 pp. 8½". 21s.
- CHAMBERS (E. G.). Psychology and the industrial worker. Cambridge Univ. Press, 1951. [x], 190 pp. 7¼". 10s. 6d.

1951]

- CHAPMAN (DOUGLAS G.). Some properties of the hypergeometric distribution with applications to zoölogical sample censuses. *Univ. California Publ. in Statist.* (1951) 1, 131-160. 10".
- CHUNG (J. H.) & DELURY (DANIEL BERTRAND). Confidence limits for the hypergeometric distribution. Univ. of Toronto Press, for Ontario Research Foundation, 1950 (London, Oxford Univ. Press). xiii, 144 pp. diag. bibliog. 12½". 17s.
- COURT (W. H. B.). Coal. London, H.M.S.O., & Longmans, Green, 1951. xii, 422 pp. 9½". 21s. (History of the Second World War.)
- DAVIS (KINGSLEY). The population of India and Pakistan. Princeton University Press, 1951 (London, Oxford Univ. Press). xvi, 263 pp. 12". 48s.
- DIXON (WILFRID) & MASSEY (FRANK J.). Introduction to statistical analysis. New York & London, McGraw-Hill, 1951. x, 370 pp. 9". 38s. 6d.
- DUPRIEZ (LÉON). Pourquoi un haut niveau de prix et rémunération en Belgique? ... *C.R. travaux Soc. d'Économie Politique Belgique* (1951). 23 pp. 8½".
- ECIMOVIC (JURAJ). Upotreba rprezentativne metode kod kontrole kvalitetepodataka popisa stoke. (English summary: Application of sampling methods in the control of livestock-census data.) *Statist. Revija* (1951), 1, 113-132. 9".
- FINNEY (D. J.). An example of periodic variation in forest sampling. *Forestry* (1950), 23, 96-111. 9½".
- The fractional replication of factorial experiments—a correction. *Ann. Eugen.* (1950), 15, 276. 11".
- Recent applications of biometrical methods in genetics. (3) Scores for the estimation of parameters. *Biometrics* (1950), 6, 221-225. 9½".
- GARDNER (T. W.). The farms and estates of Oxfordshire. University of Reading, Dept. Agricultural Economics. 80 pp. 9½". 5s. (Miscellaneous Studies No. 5.)
- GODFREY (ERNEST H.). Origin, function and future of the British Central Statistical Office. *Proc. International Statist. Conferences* (1947), III, 471-479. 9½".
- GRAY (P. G.) & CARTWRIGHT (ANN). The Medresco hearing-aid, its use and its value. *Lancet* (1950), 1170. [12] pp. 8½".
- HAMMERSLEY (J. M.). The distribution of distance in a hypersphere. *Ann. Math. Statist.* (1950), 21, 447-452. 10".
- A theorem on multiple integrals. *Proc. Camb. Phil. Soc.* (1950), 47, 274-278. 10".
- HARTLEY (H. O.) & PEARSON (E. S.). New tables of statistical functions. (1) Table of the probability integral of the *t*-distribution. (2) Table of the χ^2 integral, and of the cumulative Poisson distribution. *Biometrika* (1950), 37, 168-172, 313-324. 11". 5s.
- HEYWORTH (SIR GEOFFREY). Distribution. London, Lever Bros. & Unilever, 1951. 15 pp. 8".
- HOOPER (A.). The river mathematics. Edinburgh & London, Oliver & Boyd, [1951]. [vi], 370 pp. 8½". 18s. 6d.
- INTERNATIONAL COTTON ADVISORY COMMITTEE. Cotton: monthly review of the world situation. 4. May, 1951. Cotton: quarterly statistical bulletin. 3. June, 1951. Washington.
- ISTITUTO NAZIONALE PER L'ASSICURAZIONE CONTRO GLI INFORTUNI SUL LAVORO. *Servizio Statistico-Attuariale*. Notizie statistiche 1947-1948. Rome, 1951. xiv, 209 pp. 12". (Presented by Mr. R. D. Clarke.)
- IYER (P. V. KRISHNA). The theory of probability distribution of points on a lattice. *Ann. Math. Statist.* (1950), 21, 198-217. 10".
- JENNINGS (L. G.). Comparative prices of timber imported from Russia, Finland, and Sweden 1920-1950. Statistical graphs covering the years 1920-1947, which originally appeared in the *T.D.A. Quarterly Review*, Oct. 1948, with supplementary figures for the years 1948, 1949, and 1950. London, Timber Development Assoc. (1951). 4 pp. 11".
- United Kingdom imports of softwood and hardwood timber 1920-1950. Statistical graphs covering the years 1920-1947, which originally appeared in the *T.D.A. Quarterly Review*, April 1948, with supplementary figures for the years 1948, 1949, and 1950. London, T.D.A. (1951). 4 pp. 11".
- Wooden railway sleepers. *T.D.A. Quart. Rev.* (1951). April. 1 p. 11". (Presented by the Author.)
- KUHN (H. W.) & TUCKER (A. W.), editors. Contributions to the theory of games; H. F. Bohnenblust, G. W. Brown, M. Dresher, D. Gale, S. Karlin, H. W. Kuhn, J. C. C. McKinsey, J. F. Nash, J. von Neuman, L. S. Shapley, S. Sherman, R. N. Snow, A. W. Tucker, H. Weyl, ... Princeton Univ. Press, 1950 (London, Oxford Univ. Press). xxv, 201 pp. 10". 20s.
- LAURENT (ANDRÉ-G.). Les méthodes statistiques applicables à l'étude et au contrôle de la préparation des charbons. *L'Industrie Minérale* (1950), 88-103. 10½".
- La méthode statistique dans l'industrie. Paris, Presses Universitaires de France, 1950. 134 pp. bibliog. 7".

- LEONTIEF (WASSILY W.). The structure of American economy, 1919-1939: an empirical application of equilibrium analysis. 2nd ed. New York, Oxford Univ. Press, 1951. xviii, 264 pp. 9 $\frac{1}{4}$ ". 35s.
- LINDER (ARTHUR). Statistische Methoden für Naturwissenschaftler, Mediziner und Ingenieure ... 2nd ed. Basel, Verlag Birkhäuser, 1951. 238 pp. 9 $\frac{1}{4}$ ". 26f.
- MACBEATH (ANGUS) & PLATT (A. J.). Group accounts and holding companies. London, Gee & co., 1951. 196 pp. 8 $\frac{1}{2}$ ". 17s. 6d.
- MAUTZ (R. K.). An accounting technique for report financial transactions. Urbana, Univ. of Illinois, 1951. 91 pp. 9". (Bureau of Economic and Business Research Special Bulletins, 7.)
- MIANI-CALABRESE (DONATO). Una interpretazione psico-demografica del Pentateuco; sotto gli auspicci della Società Italiana di Economia, Demografia e Statistica. Rome, Vallerini Editore, 1951. 198 pp. 2 folding tables. bibliog. 10". 1,500 l.
- MOLLETT (J. A.). Financial results of grazing cattle in the south midlands in 1950, with a comparison of results in 1949. Univ. of Reading. Dept. of Agricultural Economics, 1951. 14 pp. 10 $\frac{1}{4}$ ". 2s. (Miscellaneous Cost Studies, 18.)
- MOOS (S.). The statistics of absenteeism in coal mining. *Manchester School* (1951). 89-108 pp. 9 $\frac{1}{2}$ ".
- MORSE (PHILIP M.) & KIMBALL (GEORGE E.). Methods of operations research ... New York, Technology Press of Mass. Institute of Technology, & John Wiley, 1951 (London, Chapman & Hall). vii, 158 pp. 10 $\frac{1}{2}$ ". 32s.
- NANDA (D. M.). Distribution of the sum of roots of a determinantal equation under a certain condition. *Ann. Math. Statist.* (1950), 21, 432-439. 10".
- OLEKIEWICZ (M.). On the efficiency of biased estimates ... *Ann. Univ. Mariae Curie-Skłodowska Lublin* (1949), Sect. A, 3, 101-128. 9 $\frac{1}{2}$ ".
- PADEN (DONALD W.) & LINDQUIST (E. F.). Statistics for economics and business. New York & London, McGraw-Hill, 1951. ix, 276 pp. 9". 32s.
- PEARCE (S. C.) & THOM (JEAN M. S.). The variability of apple trees. II. The optimum size for unguarded plots. *J. Hort. Sci.* (1949), 26, 98-108. 9 $\frac{1}{2}$ ".
- RICARDO (DAVID). The works and correspondence of David Ricardo; edited by Piero Sraffa with the collaboration of M. H. Dobb. Cambridge Univ. Press, for the Royal Economic Society, 1951. 2 vols. 9". 24s. each vol.
- SCARBOROUGH (JAMES B.). Numerical mathematical analysis. 2nd ed. Baltimore, John Hopkins Press, 1950 (London, Oxford Univ. Press). vii, 511 pp. 9 $\frac{1}{4}$ ". 48s.
- SCOTT (W. D.) & BOURKE (WALTER C.). Some aspects of business management. (1) Methods improvement—the key to increased productivity; by W. D. Scott. (2) Methods engineering and work simplification; by Walter C. Bourke. Sydney, Commonwealth Bank of Australia, 1951. 7 pp. 11 $\frac{1}{4}$ ".
- SILBERMAN (LEO). Analysis of society. London, William Hodge, 1951. x, 262 pp. 8 $\frac{1}{2}$ ". 15s.
- SITTIG (J.) & FREUDENTHAL (H.). De juiste maat: lichaamsafmetingen van Nederlandse vrouwen als basis van een nieuw maatsysteem voor dames-confectiekleding ... met een voorwoord door Dr. G. van der Wal. Leiden, L. Stafleu, 1951. 402 pp. 9 $\frac{1}{2}$ ". 20 F.
- STAPLES (RONALD) ed. "Taxation" Key to income tax and surtax. London, "Taxation" Publishing Co., 1951. 223 pp. 8 $\frac{1}{2}$ ". 7s. 6d.
- Studies of sampling techniques and chemical analysis of vegetables. (Southern Co-operative Series Bulletin, 10.) Raleigh, North Carolina Agricultural Experiment Station, 1951. 143 pp. 9".
- VENKATRANGAIYA (M.). Competitive and co-operative trends in federalism. R. R. Kale Memorial Lecture, 1951. Poona, Gokhale Institute of Politics and Economics, 1951. 41 pp. 9 $\frac{1}{4}$ ". Rs. 1-8.
- VINCI (FELICE). La politica economica dei costi comuni e del benessere generale. La politique économique des coûts communs et du bien-être général (Traduction présentée à la 13me réunion Européenne de l'Econometric Society—Louvain, 1951—et suivie du résumé de la communication lue par l'auteur à la 12me réunion Européenne de la même Société—Varese, 1950). Università degli Studi di Milano; studi dell'Istituto di Scienze Economiche e Statistiche 13. Milano, Unione Tipografica, 1951. 29 pp. 9 $\frac{1}{2}$ ". 300 l.
- WALKER (HELEN). Mathematics essential for elementary statistics: a self-teaching manual. Revised ed. New York, Henry Holt, 1951. xiii, 382 pp. 7 $\frac{3}{4}$ ". \$2.75.
- WALKER (ROBERT J.). Algebraic curves. Princeton University Press (London, Oxford Univ. Press), 1950. x, 201 pp. 9". \$4.00. (Princeton Mathematical Series, 13.)
- WHITWORTH (WILLIAM ALLEN). Choice and chance: with 1,000 exercises. Cambridge, Deighton Bell, 1901. 342 pp. 7 $\frac{1}{4}$ ".
- WILLIAMS (E. J.). Experimental designs balanced for pairs of residual effects. *Aust. J. Sci. Res. Series A* (1950), 3, 351-363 pp. 9 $\frac{1}{2}$ ".

1951]

Registration of the United Kingdom

601

REGISTRATION OF THE UNITED KINGDOM

No. I.—ENGLAND AND WALES

BIRTHS, DEATHS and MARRIAGES registered in the Calendar years 1946–1950 and in the Quarters of those years. Numbers, Annual and Quarterly Rates* per 1,000 persons living. (Deaths under 1 year of age; rate per 1,000 related Live Births. Stillbirths per 1,000 births.)

Years	1946		1947		1948		1949		1950†	
Estimated Mid-year Popln. in thousands ‡	42,700		43,050		43,502		43,785		44,020	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Live Births	819,894	19.2	886,820	20.6	776,971	17.9	731,172	16.7	692,457	15.8
Stillbirths	22,915	27	21,916	24	18,469	23	16,977	23	16,012	23
Deaths¹	492,090	11.5	517,615	12.0	469,898	10.8	510,736	11.7	510,309	11.6
Marriages	385,606	9.0	401,210	9.3	396,891	9.1	375,041	8.6	357,218	8.2
Infant Mortality ..	33,548	43	36,849	41	26,766	34	23,882	32.4	20,711	29.8
Effective reproductive rate²	1.103		1.205		1.070		1.023		0.98	
Quarters										
Live Births in the Quarters of each Calendar Year										
Jan.-Mar.	181,220	17.2	241,530	22.8	202,047	18.7	186,611	17.3	180,062	16.7
Apr.-June	203,808	19.1	235,196	21.9	203,593	18.3	192,038	17.6	181,784	16.6
July-Sept.	213,051	19.8	216,508	20.0	191,858	17.5	183,221	16.6	170,180	15.4
Oct.-Dec.	221,815	20.6	193,586	17.8	179,473	16.4	169,302	15.3	160,431	14.5
Stillbirths										
Jan.-Mar.	5,202	28	6,347	26	5,045	24	4,446	23	4,223	23
Apr.-June	5,767	28	5,831	24	4,746	23	4,496	23	4,178	23
July-Sept.	5,831	27	5,073	23	4,447	23	4,118	22	3,889	22
Oct.-Dec.	6,115	27	4,665	24	4,231	23	3,917	23	3,722	23
Deaths¹ (excluding Stillbirths)										
Jan.-Mar.	155,227	14.7	181,736	17.1	132,628	12.3	161,265	14.9	151,176	14.0
Apr.-June	113,908	10.7	118,015	11.0	110,257	10.2	119,972	11.0	120,746	11.0
July-Sept.	100,409	9.3	97,099	8.9	101,548	9.3	101,190	9.2	102,857	9.3
Oct.-Dec.	122,546	11.4	120,765	11.1	125,465	11.5	128,309	11.6	135,530	12.3
Marriages										
Jan.-Mar.	78,237	7.4	75,241	7.1	95,443	8.8	81,774	7.6	86,487	8.0
Apr.-June	101,213	9.5	109,146	10.2	92,822	8.6	95,565	8.8	80,541	7.3
July-Sept.	109,750	10.2	119,426	11.0	123,157	11.2	114,405	10.4	114,531	10.3
Oct.-Dec.	96,406	9.0	97,397	9.0	85,469	7.8	83,297	7.6	75,659	6.9
Infant Mortality										
Jan.-Mar.	9,637	56	12,561	55	8,387	41	7,532	40.4	6,537	36.8
Apr.-June	7,657	40	9,195	40	6,357	31	5,758	30.3	5,026	28.1
July-Sept.	7,100	35	7,141	32	5,514	28	4,915	26.5	4,154	24.0
Oct.-Dec.	9,154	43	7,952	38	6,508	35	5,677	32.3	4,994	30.2

* All rates are based on the estimated population as at the middle of the corresponding year.

† Provisional figures.

‡ Inclusive of non-civilians of England and Wales temporarily abroad; and exclusive of non-civilians of Foreign Countries, Dominions, etc., temporarily in England and Wales.

¹ Including deaths of non-civilians registered in England and Wales.

² Based not upon current, but upon estimated future mortality.

No. II.—SCOTLAND

BIRTHS, DEATHS and MARRIAGES registered in the Calendar years 1946–1950, and in the Quarters of those years. Numbers, Annual and Quarterly Rates, per 1,000 persons living.* (Deaths under 1 year of age, rate per 1,000 Live Births; Stillbirths per 1,000 Births.)

Years	1946		1947		1948		1949†		1950†	
Estimated Popln. in thousands‡	4,901		5,139		5,169		5,175		5,175	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Live Births	104,413	20.3	113,147	22.0	100,344	19.4	95,674	18.5	92,528	17.9
Stillbirths	3,483	32	3,563	31	2,966	29	2,666	27	2,558	27
Deaths	64,605	13.1	66,200	12.9	60,979	11.8	63,488	12.3	63,996	12.4
Marriages	45,785	8.9	44,360	8.6	43,747	8.5	41,709	8.1	40,478	7.8
Infant Mortality ..	5,621	54	6,309	56	4,486	45	3,961	41	3,569	39
Quarters										
Live Births in the Quarters of each Calendar Year										
Jan.–Mar.	22,910	18.1	30,479	24.1	25,324	19.8	24,230	19.0	23,542	18.5
Apr.–June	25,851	20.2	30,366	23.7	26,561	20.7	25,424	19.7	24,645	19.1
July–Sept.	27,033	20.9	27,028	20.8	24,389	18.7	23,324	17.9	22,497	17.3
Oct.–Dec.	28,619	22.1	25,274	19.5	24,070	18.5	22,696	17.4	21,844	16.8
Stillbirths										
Jan.–Mar.	810	34	1,018	32	760	29	707	28	673	28
Apr.–June	864	32	913	29	775	28	710	27	659	26
July–Sept.	854	31	853	31	711	28	642	27	627	27
Oct.–Dec.	955	32	779	30	720	29	607	26	599	27
Deaths (excluding Stillbirths)										
Jan.–Mar.	19,741	16.3	21,198	16.8	16,825	13.1	19,222	15.1	18,647	14.7
Apr.–June	15,185	12.2	15,653	12.2	14,698	11.4	15,274	11.8	14,986	11.6
July–Sept.	13,594	10.8	13,447	10.4	13,652	10.5	13,119	10.1	13,341	10.2
Oct.–Dec.	16,085	12.7	15,902	12.3	15,804	12.2	15,873	12.2	17,022	13.1
Marriages										
Jan.–Mar.	9,971	7.9	9,497	7.5	9,966	7.8	10,638	8.4	11,118	8.7
Apr.–June	11,466	9.0	11,241	8.8	10,497	8.2	9,209	7.1	8,685	6.7
July–Sept.	12,839	9.9	12,747	9.8	13,518	10.4	12,787	9.8	11,850	9.1
Oct.–Dec.	11,509	8.9	10,875	8.4	9,766	7.6	9,075	7.0	8,825	6.8
Infant Mortality										
Jan.–Mar.	1,579	69	1,915	63	1,303	51	1,225	51	1,080	46
Apr.–June	1,221	47	1,609	53	1,144	43	913	36	841	34
July–Sept.	1,222	45	1,353	50	972	40	823	35	737	33
Oct.–Dec.	1,599	56	1,432	57	1,067	44	1,000	44	911	42

* Death rates for 1946 are based on civilian deaths and civilian population; for 1947, 1948 and 1949 they are based on all deaths registered in Scotland, related to the total population. Birth and marriage rates for the same years are based on the total population (including persons in the Services). Birth, death and marriage rates for 1950 are based on the estimated home population of Scotland.

† Provisional figures.

‡ 1946 = Mean of four quarterly estimates of the civilian population.

1947–49 = Estimated mid-year total population.

1950 = Home population. The estimated home population is the civilian population (including members of the Mercantile Marine at home and abroad) together with members of the armed forces stationed in the country.

1951]

Registration of the United Kingdom

603

No. III.—NORTHERN IRELAND

BIRTHS, DEATHS and MARRIAGES registered in the Calendar years 1946–1950 and in the Quarters of those years. Numbers, Annual and Quarterly Rates* per 1,000 persons living. (Deaths under 1 year of age; rate per 1,000 Live Births.)

Years	1946		1947		1948		1949		1950 ³	
Estimated ² Mid-Year Popln. in thousands	1,333		1,339		1,351		1,360		1,369	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Live Births	30,134	22.6	31,254	23.3	29,532	21.6	29,106	21.4	28,794	21.0
Stillbirths ¹					Not registered					
Deaths	16,666	12.5	16,913	12.6	15,125	11.2	15,652	11.5	15,839	11.6
Marriages	9,801	7.4	9,517	7.1	9,360	6.9	9,216	6.8	9,072	6.6
Infant Mortality	1,626	5.1	1,658	5.3	1,347	4.6	1,317	4.5	1,165	4.0
Quarters										
Live Births in the Quarters of each Calendar Year										
Jan.–Mar.	7,278	21.8	8,318	24.9	7,412	22.1	7,379	21.8	7,275	21.3
Apr.–June	7,924	23.8	8,539	25.5	8,030	23.9	7,764	22.9	7,725	22.5
July–Sept.	7,646	22.9	7,516	22.4	7,262	21.6	7,193	21.2	7,090	20.7
Oct.–Dec.	7,286	21.9	6,881	20.5	6,828	20.2	6,770	19.9	6,704	19.5
Deaths† (excluding Stillbirths)										
Jan.–Mar.	5,435	16.3	5,902	17.7	4,313	12.8	4,758	14.0	4,552	13.3
Apr.–June	4,026	12.1	4,011	12.0	3,817	11.4	3,812	11.2	3,924	11.4
July–Sept.	3,280	9.8	3,276	9.8	3,323	9.9	3,228	9.5	3,222	9.4
Oct.–Dec.	3,925	11.8	3,724	11.1	3,672	10.9	3,854	11.3	4,141	12.1
Marriages										
Jan.–Mar.	2,224	6.7	1,820	5.5	2,150	6.4	1,975	5.8	2,049	6.0
Apr.–June	2,509	7.5	2,517	7.5	2,158	6.4	2,287	6.7	2,075	6.1
July–Sept.	2,840	8.5	2,905	8.6	2,972	8.8	2,862	8.4	3,058	8.9
Oct.–Dec.	2,228	6.7	2,275	6.8	2,080	6.2	2,092	6.1	1,890	5.5
Infant Mortality ²										
Jan.–Mar.	464	6.4	497	6.0	395	5.3	402	5.5	323	4.4
Apr.–June	436	5.5	442	5.2	352	4.4	297	3.8	284	3.7
July–Sept.	331	4.3	314	4.2	302	4.1	309	4.3	253	3.6
Oct.–Dec.	388	5.3	405	5.9	298	4.4	309	4.6	305	4.5

* Rates are based on Civilian population only.

† Civilians only.

¹ Stillbirths are not registered in Northern Ireland. The birth of one living child and one stillborn, or one living child and two stillborn, is counted as one birth.

² The annual figures have been corrected, so that slight differences appear between them and the aggregates of the quarterly figures.

³ By courtesy of the Registrar-General for Northern Ireland.

No. IV.—EIRE

BIRTHS, DEATHS and MARRIAGES registered in the Calendar years 1946–1950 and in the Quarters of those years. Numbers, Annual and Quarterly Rates* per 1,000 persons living. (Deaths under 1 year of age, rate per 1,000 Live Births.)

Years	1946		1947		1948		1949†		1950†	
Estimated Mid-year Popln. in thousands	2,963		2,972		2,998		2,991		3,006	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Live Births	67,922	22.9	68,978	23.2	65,930	22.0	63,954	21.4	63,263	21.0
Stillbirths†					Not registered					
Deaths	41,457	14.0	44,061	14.8	36,357	12.1	38,098	12.7	37,835	12.6
Marriages	17,525	5.9	16,200	5.5	16,115	5.4	16,299	5.4	16,173	5.4
Infant Mortality ..	4,390	65	4,687	68	3,313	50	3,292	51	2,866	45
Quarters										
Live Births in the Quarters of each Calendar Year										
Jan.–Mar.	17,005	23.0	17,537	23.6	16,310	21.8	16,329	21.9	15,931	21.2
Apr.–June	18,122	24.5	18,946	25.5	18,143	24.2	16,605	22.2	16,936	22.5
July–Sept.	17,230	23.3	17,424	23.5	16,385	21.9	16,490	22.1	15,907	21.3
Oct.–Dec.	15,565	21.0	15,071	20.3	15,092	20.1	14,530	19.4	14,489	19.3
Deaths (excluding Stillbirths)										
Jan.–Mar.	13,042	17.6	15,975	21.5	10,612	14.2	11,018	14.7	11,218	15.0
Apr.–June	10,515	14.2	11,161	15.0	9,333	12.5	9,918	13.3	9,724	12.6
July–Sept.	8,539	11.5	8,288	11.2	7,865	10.5	8,107	10.8	7,721	10.3
Oct.–Dec.	9,361	12.6	8,637	11.6	8,547	11.4	9,055	12.1	9,172	12.2
Marriages										
Jan.–Mar.	4,478	6.0	3,769	5.1	3,568	4.8	3,814	5.1	3,457	4.6
Apr.–June	4,147	5.6	4,023	5.4	4,000	5.3	3,594	4.8	3,757	5.0
July–Sept.	5,161	7.0	4,899	6.6	5,011	6.7	5,280	7.1	5,600	7.5
Oct.–Dec.	3,739	5.0	3,599	4.8	3,536	4.7	3,611	4.8	3,359	4.5
Infant Mortality										
Jan.–Mar.	1,408	33	1,639	33	1,059	65	895	55	937	59
Apr.–June	1,051	28	1,241	36	857	47	825	50	752	44
July–Sept.	948	25	832	48	649	40	722	44	585	37
Oct.–Dec.	983	63	975	65	748	50	850	58	592	41

* Rates are based on the total estimated population as at the middle of the corresponding year.

† Provisional figures.

‡ Stillbirths are not registered in Eire. The births of one living child and one stillborn, or of one living child and two stillborn, are counted as one birth.

INDEX TO VOL. CXIV.

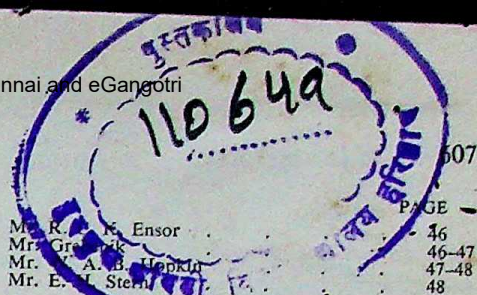
YEAR 1951

(Statistical and Current Notes are indicated by the letters S.N. and C.N. respectively.)

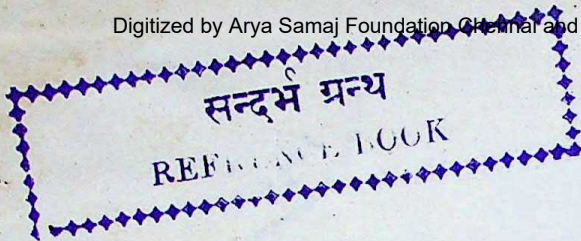
	PAGE		PAGE
ADDITIONS to the Library	129, 280, 442, 596	Jensen (A.). Moe's principle	104
AGRICULTURE. Agricultural rents in Eng- land and Wales. (S.N.)	271	Johnson (N. L.) and Tetley (H.). Statistics. Vol. II	253
— Agricultural Statistics of the United Kingdom. See BRITTON (D. K.) and HUNT (K. E.).		Kafka (F.). Statistics without numbers	108
— Earnings and conditions of employ- ment in. See PALCA (H.) and DAVIES (I. G. R.).		Kendall (M. G.). Rank correlation methods	99
ANNUAL General Meeting	576	Klein (L. R.). Economic fluctuations in the United States, 1921-41	425
ANNUAL REPORT of the Council	559	Kuhn (H. W.) and Tucker (A. W.). (Ed.). Contribution to the theory of games	577
BANK OF ENGLAND. Weekly return, 1950	137	Mann (H. B.). Analysis and design of experi- ments	100
BIBLIOGRAPHY of applications of mathe- matical statistics to economics, 1943- 49. By A. D. Scott	372	Maverick (L. A.). Economic statistics	103
— See also RECENT ADVANCES in mathematical statistics.		Miller (D. C.). Taxes, the Public Debt and transfers of income	263
BOOKS. Reviews and notices of statistical and economic books:		Morey (L.) and Hackett (R. P.). Fundamentals of Government accounting	586
Abramowitz (M.). Inventories and business cycles	261	Morgenstern (O.). On the accuracy of eco- nomic observations	428
American Statistical Association. Acceptance sampling	257	Munroe (M. F.). Theory of probability	578
Bank of England. United Kingdom overseas investments (S.N.)	270	National Bureau of Economic Research. Con- ference on research in income and wealth, Vol. 11	423
Beer (E. J. de). (Ed.). The place of statistical methods in biological and chemical experi- mentation	255	National Bureau of Economic Research. Con- ference on Research in income and wealth, Vol. 12	583
Brockmeyer (E.), Halström (H. L.) and Jensen (A.). Life and works of A. K. Erlang	103	National Bureau of Standards. Tables of the binomial probability distribution	256
Burn (J. H.), Finney (D. J.) and Goodwin (L. G.). Biological standardization	101	Office Management Association. Clerical sala- ries analysis (S.N.)	118
Butterbaugh (G. I.). A bibliography of statistical quality control; Supplement	430	Paish (F. W.). The post-war financial problem and other essays	427
Chambers (E. G.). Psychology and the industrial worker	579	Perry (W. L. M.). Reports on biological standards. VI. The design of toxicity tests	102
Chang (Tse Chun). Cyclical movement in the balance of payments	580	Quenouille (M. H.). Introductory statistics 92nd Report of the Commissioners of Inland Revenue (S.N.)	254
Clark (Colin). The conditions of economic progress	265	Report of the Interdepartmental Committee on Social and Economic Research (S.N.)	118
Clarke (Charles E.). Social insurance in Britain	108	Saulnier (R. J.). Urban mortgage lending by Life Insurance Companies	110
Cox (P. R.). Demography	257	Schrock (E. M.). Quality control and statis- tical methods	255
Crew (A.). Economics for commercial students and business men. 13th ed.	265	Scope Year Book of Industry, trade and finance (C.N.)	119
Delens (A. H. R.). Principles of market re- search	105	Seers (D.). Changes in the cost of living and the distribution of income since 1938	109
Deming (W. E.). Some theory of sampling	100	Singapore Department of Social Affairs. A Social Survey of Singapore, 1947	114
Devons (E.). Planning in practice	266	Statistical Office of the United Nations. Index numbers of industrial production	423
Economic Commission for Europe—Annual Bulletin of Transport Statistics	260	Tinbergen (J.). The dynamics of business cycles	260
Feller (W.). Introduction to probability theory and its applications	249	United Nations Department of Economic Affairs—Economic survey of Europe in 1950	582
Fortet (R.). Calcul des probabilités	578	United Nations: Economic survey of Asia and the Far East—Economic development of Latin America and its principal problems	112
General Register Office—Classification of occupations (S.N.)	270	United Nations: National income statistics, 1938-48 (S.N.)	271
Greece, Ministry of Co-ordination—National income of Greece	272	United Nations: Population census methods	258
Guilford (J. P.). Fundamental statistics in psychology and education	102	U.S. Bureau of the Census. Historical statistics of the United States, 1789-1945	110
Hartree (D. R.). Calculating instruments and machines	106	Vance (L. L.). Scientific method for auditing	584
H.M.S.O. Labour statistics (S.N.)	117	Wald (A.). Statistical decision functions	250
Jaffe (A. J.). Handbook of statistical methods for demographers	581	Whittle (P.). Hypothesis testing in time series analysis	579
Jasny (N.). The socialized agriculture of the U.S.S.R.	113	Wilkins (L. T.). Domestic utilization of heating appliances and expenditure on fuels in 1948-49	587
Jeffreys (J. B.), Maccoll (M.) and Levitt (G. L.). Distribution of consumer goods	104	Other new publications	115
		BRITISH motor industry, statistics of. See FORD (C. V.).	

	PAGE		PAGE
BRITTON (D. K.) and HUNT (K. E.). The Agricultural Statistics of the United Kingdom	59-98	GRÜNHUT (M.). Statistics in criminology	139-161
CENSUS, 1951. Preliminary report of the Registrar-General (S.N.)	589	1. Beginnings	139
CLARK (COLIN). Urban population densities	490	2. Social studies in criminology	141
COMRIE (L. J.). Obituary notice	120	3. Published criminal statistics	145
CORLETT (W. J.). See MORGAN (D. J.) and CORLETT (W. J.)		4. Problems of international comparability	154
CRIMINOLOGY, statistics in. See GRÜNHUT (M.).		5. Conclusions and references	157
COUNCIL, Report of. See ANNUAL REPORT of the Council.		Discussion: Dr. Mannheim; Mr. T. S. Lodge; Mr. Ronald Howe; the President; Dr. Grünhut in reply	157-161
DAVIES (I. G. R.). See PALCA (H.) and DAVIES (I. G. R.).		HILL (Prof. A. BRADFORD, D.Sc., Ph.D.). The doctor's day and pay: Some sampling inquiries into the pre-war status (Presidential Address)	1-34
DEANE (MARJORIE). United Kingdom publishing statistics	468	I. The day's work: counting of A's and V's; the randomly selected sample; holidays, illness, instructions; monthly samples; services rendered; uniformity of monthly groups; special services	2-18
DIFFERENCES in response rates of experienced and inexperienced interviewers. See DURBIN (J.) and STUART (A.).		II. Income of the general practitioner	18-26
DOCTOR'S day and pay, The. See HILL (Prof. A. BRADFORD).		III. Income of the specialist	26-34
DURBIN (T.) and STUART (A.). Differences in response rates of experienced and inexperienced interviewers	164-205	Proceedings of the Meeting: Sir Geoffrey Heyworth; Dr. David Hegan; the President in reply	34-36
1. Introduction	164	HISTORICAL SURVEY of the development of sampling theories and practice. See SENG (YOU POH).	
2. General description of survey	165	HOUBLON-NORMAN Fund. Awards, 1951-52 (C.N.)	434
3. The questionnaires	167	HOUTHAKKER (H. S.). Some calculations on electricity consumption in Great Britain	359
4. The interviewers	168	HUNT (K. E.). See BRITTON (D. K.) and HUNT (K. E.).	
5. The sample	169	INDICES of wholesale prices. See STAFFORD (J.).	
6. The experimental design	169	INFLUENCE of price in international trade. See MORGAN (D. J.) and CORLETT (W. J.).	
7. Field work	171	INTERNATIONAL trade: influence of price in. See MORGAN (D. J.) and CORLETT (W. J.).	
8. Coding	172	INTERVIEWERS, experienced and inexperienced. See DURBIN (J.) and STUART (A.).	
9. Main results	172	ISRAEL, North. Association of economists and statisticians (C.N.)	591
10. Summary and conclusions	183	MARTIN (W. J.). A comparison of the trends of male and female mortality	287-298
Discussion: Dr. D. J. Finney; Mr. R. F. Fowler; Mr. Louis Moss; Dr. Mark Abrams; Dr. H. Durant; Mr. Tom Cauter; Mr. T. Corlett; Mr. J. L. Williams; Mr. J. I. Mason; Mr. W. F. Harris; Mr. J. A. Reece; the authors in reply	196-205	Introduction	287
EARNINGS and conditions of employment in Agriculture. See PALCA (H.) and DAVIES (I. G. R.).		Regional comparisons	289
ELECTIONS to Fellowship . 36, 48, 162, 206, 306, 358, 467		Specific age comparisons	291
ELECTRICITY consumption in Great Britain, some calculations on. See HOUTHAKKER (H. S.).		Social class	295
EMPLOYED persons: absence through illness and industrial injuries (S.N.)	117, 270, 432, 589	Occupation	295
— age groupings (S.N.)	432	Summary	296
— See also WORKING population.		Discussion: Mr. Starke; Dr. J. O. Irwin; Dr. Swinscow; Dr. Logan; Mr. R. D. Clarke; Mr. F. J. Lloyd; Mr. P. R. Cox; the President; Mr. P. H. Leslie; Dr. W. J. Martin in reply	299-306
EPDS (Sir GEORGE), K.B.E., C.B. Obituary notice	435	MATHEMATICAL statistics: bibliography, 1943-47. See RECENT ADVANCES.	
EXTENT of the public sector of the economy in recent years. See RIDLEY (T. M.).		MORGAN (D. J.) and CORLETT (W. J.). The influence of price in international trade: a study in method	307-358
FORD (C. V.). Statistics of the British motor industry	394		

Index



	PAGE		PAGE
Economic assumptions in simple regression	308	Mr. R. G. D. Ensor	46
Calculations using simple regression	313	Mr. G. E. M.	46-47
Introductions of other variables	316	Mr. A. B. Hapkin	47-48
Autocorrelation of error terms	318	Mr. E. M. Stern	48
Simultaneous equations approach	319		
Construction of models for simultaneous equations approach	321	SAMPLING theories and practice, historical survey of the development. See SENG (YOU POH).	
Model I—Wheat (Australia, New Zealand, Argentina)	323	SCOTT (A. D.). Bibliography of applications of mathematical statistics to economics, 1943-49	372
II—Wheat (Australia, New Zealand and rest of world)	328	SENG (YOU POH). Historical survey of the development of sampling theories and practice	214
III—Steel plates into Sweden	330	STAFFORD (J.). Indices of wholesale prices	447-467
IV—Butter into the United Kingdom	333	Earlier history in the United Kingdom	447
Concluding remarks on the models	339	The present index	448
General conclusions	341	Indices of materials	450
Appendices (data)	347	Indices of final goods	451
Discussion: Mr. Stone; Mr. J. Durbin; Professor J. E. Meade; Mr. Houthakker; the authors in reply	352-358	Arithmetic or geometric mean	452
		Weighting	452
OBITUARY—		Base period	452
Comrie (L. J.)	120	Form of the indices	453
Epps (Sir George)	435	Prices: Sampling, collection, changes in specification of goods, errors, quotations, seasonal commodities	454-7
PALCA (H.) and DAVIES (I. G. R.). Earnings and conditions of employment in agriculture	50-58	Discussion: Professor R. G. D. Allen; Mr. Leak; Mr. J. L. Nicholson; Mr. Stone; Mr. Vibart; Professor Richardson; Mr. Friday; Mr. Stafford in reply	460-467
POPULATION: Report of Royal Commission. Discussion on. See ROYAL COMMISSION.		Statist, Editor of. Wholesale prices in 1950—	
Geographical distribution, 1951 (S.N.)	590	Statist annual index numbers	408
See also URBAN POPULATION.		Ten-year averages, 1848-57 to 1941-50	408
PRICES. Retail index numbers (S.N.)	116, 269, 431, 588	Monthly fluctuations since 1904	409
Wholesale. See Statist, Editor of.		Quarterly movements of prices from 1939	412
Indices of. See STAFFORD (J.).		Construction of tabular statements	413
PUBLISHING Statistics, United Kingdom. See DEANE (MARJORIE).		Silver and gold prices	414-416
		Average prices of commodities 1922-50	417-422
RECENT ADVANCES in mathematical statistics: Bibliography, 1943-47	497-558	STATISTICAL and economic articles in recent periodicals	122, 273, 436, 592
A. Biographical and general	500	STATISTICS in criminology. See GRÜNHUT (M.).	
B. Theory	500-525	of the British motor industry. See FORD (C. V.).	
Elementary probability, 502; distribution functions, 504; sampling theory and problems, 511; stochastic processes, 519.		STUART (A.). See DURBIN (J.) and STUART (A.).	
C. Applications	525-558	UNEMPLOYMENT statistics (S.N.)	117, 270, 431, 589
Biology, 525; agriculture, 537; forestry, 546; genetics, 548; psychology, 549; industry, 550; computations, 554; miscellaneous, 556.		UNITED KINGDOM publishing statistics. See DEANE (MARJORIE).	
REVENUE of the United Kingdom, 1950	135	URBAN POPULATION densities. See CLARK (COLIN).	
RIDLEY (T. M.). Note on the extent of the public sector of the economy in recent years	207	figures from 1951 census (S.N.)	590
ROYAL Commission on population, Reports. Discussion on	38-48	WAGES, weekly rates and average earnings (S.N.)	116, 269, 431, 588
Sir A. Carr-Saunders	38-40	WORKING population, numbers (S.N.)	116, 269, 431, 588
Sir Hubert Henderson	40-42		
Sir George Maddex	42-44		
Prof. D. V. Glass	44-46		



सन्दर्भ ग्रन्थ
REFERENCE BOOK

Compiled
1999-2000

